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THE MEASUREMENT OF PRODUCTION MOVEMENTS

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PREFACE

This monograph analyses some of the problems of principle involved in measuring production movements; and illustrates them by setting out in full detail the methods used in constructing the London and Cambridge Economic Service Index of Industrial Production, which since February, 1948, has been published quarterly in the *Bulletin** of the Service. The Department of Applied Economics at Cambridge is responsible for constructing and producing this Index, which continues that published by the Service before the war, but brings into use the much fuller information now available on many aspects of British production.

The authors owe a special word of thanks to Mrs. Hugh Jones (*née* Goodacre), formerly Senior Computor of the Department, whose hard work and unfailing accuracy enabled the Index to be completed speedily. Much of the detailed work of preparation has fallen on Mr. F. Winter, of the Department's research staff; the index of subjects was prepared by Mr. Adams; and the laborious task of checking all the calculations has been done with great care by Mr. W. T. Osborn. To these, to Mrs. Wilkes (Secretary to the Director) and to others who have helped and are helping with the monthly preparation of the Index, our thanks are due. Nor would the work have been possible without the ready co-operation of many organisations who regularly supply us with unpublished figures. The generosity with which almost every request we have made has been granted has impressed us as one of the happiest features of the venture.

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INTRODUCTION

Our original objective in writing this book was primarily to set out in detail the methods by which the London and Cambridge Economic Service index of industrial production is computed. We conceived it to be an essential part of the work of preparing an index to enable users to see for themselves exactly what activities are supposed to be covered by each industrial group and, more important still, what basic series are used to represent them and what weight each carries.

This original objective is covered in Part II of the book, which also indicates briefly how the weights were arrived at and gives special notes on the details of the separate calculation made to obtain broadly comparable figures for 1935.

It was evident, however, that a mere recital of these particulars could not really give users a proper picture of the index unless it were accompanied by a discussion of the fundamental concept underlying it, and of the principles followed in trying to translate that concept into figures. Part I of the book was therefore designed to cover the matters of principle involved.

When we came to write Part I, however, our ideas expanded and became rather more ambitious. As teachers of statistics we had all felt the lack of a book that really dealt with the problems involved in reconciling the theoretical principles of index-making with the practical necessity of using data which are inevitably incomplete and not on the basis desired. Having wrestled with these problems ourselves (and as usual discovered or rediscovered many of the principles in the process) we considered that our experience provided useful material for filling the gap.

Part I has therefore expanded beyond our original concept, and the emphasis of the book has shifted to a discussion of the problems of measuring production movements, with the London and Cambridge index providing the illustrations. We hope that such a book will be useful for several classes of people—the users of the index, people engaged in compiling index-numbers, and general students of statistical methods and principles. Inevitably it is somewhat uneven in the standard of difficultness, and equally inevitably the earlier chapters imply some broad knowledge of the subjects (e.g., weighting) which are discussed later. But we hope that it will help readers to trace the logical process of index-making, from the conception of a broad idea of something for which one would like a measure, through its more precise definition in the light of practical possibilities, the choice of basic series to serve as indicators of movement for different industries, the adjustment of these to fit as nearly as possible to the common objective, and finally their combination into an index.

We have tried to display frankly the main assumptions which are needed to justify the use of an index as a measure of production changes. Our standard of honesty in dealing with the reader may have slipped from time to time—there are doubtless many places where the word "estimate" should be replaced by "guess"—but our object has been to reveal the inevitable weaknesses and acts of faith rather than to conceal them. We have tried to put the emphasis where it rightly belongs—on the question whether the indicators really reflect movements in the field which they are supposed to represent—rather than hide this problem behind an elaborate discussion of weighting formulae and the like.

A number of the conclusions reached by the discussions in Part I are like the solution to Columbus' problem with the egg—very obvious when you have found the answer. Experience has shown us, however, that these answers are more likely to be forgotten than Columbus' when it comes to practical application, and we have therefore devoted more space to them than might seem necessary. Since concrete examples are usually the best means of familiarising an idea we have also added a final chapter setting out some of the points on which we realised too late that we had not made the best decision, and others where we discovered our errors in time. We hope that this account may help others to make right decisions from the outset.

Part III of the book reviews very briefly the results of attempts which have been made to measure British industrial production from 1700 onwards. There has previously been no connected account of these scattered investigations, and it seemed to be very useful to bring them together and combine some of the results into a single table.

Finally, this chapter would not be complete without a note of two matters which are *not* included in the book. The first is an account of the problems inherent in collecting the basic data which are used for computing an index of production: the collection of accurate information of the right kind is by far the most important part of preparing a good index, and it presents a number of very important problems both of principle and of practice, but it lies outside the scope of this book.

The second is a proper comparison between the London and Cambridge Economic Service index and the official interim index of production. We had hoped to include at least one chapter on this subject, which would probably have provided a great many illustrations of the extent (if any) to which results differed when somewhat different methods were adopted for treating a particular problem. Such comparisons are, however, impossible with the scanty amount of information about the official index which is available at the time of our going to press; it needs, at the very least, a full list of the series used (such as was published for the London and Cambridge Economic Service index with the first set of figures) and preferably something analogous to Part II of this book. It is earnestly to be hoped that the public will not have to wait so long for a proper account of the interim index of production as it did with the interim index of retail prices.

CHAPTER 2

THE OBJECTS AND SCOPE OF THE INDEX

In the construction or appraisal of any index-number, it is essential to be clear as to the objects it is intended to serve : what is it that you are trying to measure, and why ?

For the constructor of the index-number this problem has to be approached by stages. He will usually start with a *broad* idea of his objective ; in the process of defining it more closely he will generally see that there are, in fact, several distinct, though possibly closely allied, concepts of the thing which he had in mind, and he may well feel that several would, in fact, be useful things to measure ; his choice between these alternative concepts may then turn more on the nature of the data available than on their intrinsic merits. Indeed, this process of examining the data available and seeing what they can in fact be used to measure, is often the crux of the whole matter and may force him to modify somewhat the definition of the concept which he had in mind. There are two dangers to be avoided : on the one hand it is no use producing a very accurate index-number of some concept which is of no economic significance ; on the other hand, it is no use pretending that your index measures the movements of something which you would like to study, if in fact you have not got important data which are needed for that purpose.

The construction of a monthly index of production supplies a very good illustration of the problems involved. The *broad* objective is fairly clear : it is to fill part of the " gap " in our information between the mass of detailed series on the output of particular commodities, which now appear at frequent intervals, and the annual White Paper on the national income. The former are essential for many special purposes, but they do not readily enable one to form a comprehensive view of the movements in activity of the whole economy, or of large sections of it. The latter is comprehensive, but it only appears annually, and much of the information is given only in terms of value, without adjustment for price changes.

The broad objective of the index, then, is to provide a monthly series showing, in real terms, the movement of output or activity in a large sector of the economy taken as a whole, with a manageable number of subsidiary series for important sub-sectors. Ideally, of course, one would like to cover the whole economy in this way, but there are obvious difficulties about this, and the first main problem is to define the field to be covered, or the " scope " of the index.

Scope of the Index

There is no inherent merit in covering that particular section of economic activity known as " industrial production," and the fact that

our index bears that title certainly does not imply that " production " is economically more important than transport, or distribution, or entertainment, or any other sector of the economy ; nor, of course, is it right to assume that the real national income or the total activity of the country will move closely with its industrial production " because the other sectors are dependent on it."* The choice of this field is really due to the fact that it is the most " useful " one for which it is in fact possible to produce an index. Industrial production is a concept of which most people carry a broad picture in their mind, and about the aggregate of which it is desirable to have information, and sufficient data are available.

It is useful to consider this point a bit further. For an *annual* index there would clearly be a strong case for including agriculture, since an index of " total physical production " is both logically and economically superior. But the nature of the productive process makes it impossible to include large parts of agriculture in a *monthly* index, even if all possible information were available. We could include those parts of agriculture for which suitable monthly data exist and produce an index of (say) " industrial production, milk and eggs," but few people would be interested in the movement of output in that particular field ; it would *not* be legitimate to pretend that milk and eggs were representative of agriculture as a whole and produce a monthly index of total physical production by giving them a correspondingly large weight.

Similarly, it would be relatively easy to extend the index to cover some other activities, such as rail transport. But once more the resultant series, though reasonably accurate, would relate to a sector of the economy which had been enlarged in such a way as to make it of little interest as an aggregate.

It may well be that further study will reveal some larger field than that of industrial production, for which it is both possible and useful to construct a monthly index. Even so, however, the series for industrial production would be shown as one of its components, so that its construction is a useful first step.

Excluded Activities

Within the field of what would ordinarily be classed as industrial production there are, of course, numerous kinds of output about which there are no monthly data. This presents the constructor of the index with what might be called " the conflict between purism and expediency." Shall he use his data to produce an accurate measurement of something and then try to describe what it is he has measured ? Or shall he stick to the concept of " total industrial production " and produce the best index he can for that concept, even though it may, in fact, give a very imperfect measure of its movement ?

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* *Cf.* the discussion on page 124.

In pre-war days it must be confessed that this dilemma was not usually faced as honestly as it should have been. Most index numbers of production were assumed to reflect " total industrial production," even though the information on which they rested was extremely skimpy. It would almost be fair to say that as the gaps in the data were inevitably enormous, it was considered as reasonable to say that the available series " represented " *total* industrial production as to say that they represented any other field. It was clearly impossible to secure a direct measurement of changes in output for more than a fairly small part of the field, and there seemed nothing for it but to hope that this part would prove a representative sample.

It is impossible to enter here on a discussion of the theoretical sampling problems involved in this matter. Perhaps we may dogmatise by saying that the theory of sampling does not provide much justification for doing more than *hope* that such an index will give a reasonable indication of the actual movement ; but we may add that *over short periods of time* the hope may often be more nearly fulfilled than one might imagine from its sketchy basis. We must firmly point out, however, that this tendency for the movements in the total to be broadly similar to those in an arbitrary collection of parts is very likely to prove a broken reed in disturbed times. Even in the pre-war years it was difficult to say whether the various indices of production should be regarded as indicating the movements in *total* industrial production, or in production *excluding finished munitions*. They did not, as far as is known, incorporate any series directly measuring the output of such munitions : the shipbuilding figures, for example, related to merchant ships only. But there were plenty of other things which were not directly represented, and munitions production would indirectly influence various component series, so why should it not be considered as " covered " in the same way as (say) toys ?

The plain fact was that the pre-war indices did not *measure* the movement in total production either with or without munitions, and the " hope " that they would show a similar movement to one or the other was largely based on wishful thinking. The growth of rearmament made it clear that no index could be right for *both* concepts, but there was no solid reason for saying they were right for either.

For the post-war period the greatly increased supply of information makes a more scientific approach possible. At the same time it is obviously much less justifiable to rely on the assumed tendency for very loosely related things to move together (the index-maker's version of " the hidden hand "), since the times are in many respects so abnormal. This raises problems which have to be considered in detail as to how many indicators are needed to cover a given part of the field, but it also makes it both necessary and practicable to consider rather carefully what field the index should purport to cover, and to strike a sensible compromise between purism and expediency.

Our procedure was essentially to start from the concept of total industrial production, broadly as defined for census of production

purposes, and then consider whether there were any substantial types of activity for which we could not get a reasonable indicator of output. If there were, then we defined our field as excluding these, rather than pretend that they could be " represented " by some combination of other series. But we were very reluctant to throw anything out in this way if it would normally be thought of as clearly part of industrial production, or if the remaining field would not correspond with something which people could reasonably think of as a useful aggregate.

On minor items therefore we frankly accepted second-rate indicators, or relied on the hope that they would move with others, if this was at all plausible, rather than define the scope of the index as excluding a whole host of miscellaneous activities. Our main concern with these second-rate indicators was to try to minimise the risk of substantial cumulative errors ; we were not so concerned about discrepancies which would disappear if the series were averaged over a few months and we considered it clearly right to use quarterly data where nothing else was available.

The final scope of the index may be seen in full detail from the table on pages 86 to 105, or from the summary in Appendix 1, which shows how it is related to that of the 1935 census of production. The major omissions as compared with the census are the production of finished munitions (whether in Government or private establishments) ; repair work of all kinds except merchant ship repairs ; water supply ; road work ; and civil engineering work for public utility undertakings.

The scope of the index is defined as excluding the above activities. A very few minor census trades, or parts of trades, were in fact also omitted from the calculations in the sense that no weight was attached to any particular series to represent their net output, but they remain within the formal scope of the index. In effect, they are assumed, collectively, to move with the whole index ; there is no logical justification for this " hope," but we do not know of any better indicator of their movements.*

On finished munitions we clearly had no choice but to omit them, since no statistics are available and in a period of reconversion after a war it would obviously be entirely wrong to assume that their output moved with that of other things produced by the same industry, e.g., naval ships with merchant ships, tanks with motor vehicles, etc. There are, however, many purposes for which one would actually prefer an index which excluded munitions production so that this case of Hobson's choice was not as unwelcome as some. The unfortunate point is, however, that

* We do not subscribe to the theory adopted by the Central Statistical Office for the official index that the weights appropriate to these products should always be apportioned to other items within the same industry, so that each main industry group is given its " proper " weight. This amounts to assuming that the missing items will move with the others in the group and may frequently be the best course, but there should be nothing automatic about it. It would be silly, for example, to argue that there is any tendency for gold refining to move with the other metal series in its group, and there would be no justification for increasing their weight because we have no data on gold refining. There is also the further point that one-quarter of the missing trades are in the miscellaneous group for which the indicators are often poor, so that extra weight should not be given to them.

the production of the steel and other materials or fuel used in making the munitions is inevitably included in the index ; only the " fabrication " and assembly are omitted.

The exclusion of repairs was also largely a matter of Hobson's choice, owing to lack of information ; it would be manifestly unwarranted to assume that repairs of shoes, for example, moved with the output of new shoes, when relaxation of rationing would produce contrary movements. The definition of " production " is, however, bound to involve some arbitrary decisions at the boundary, and repair work is one of the doubtful cases. From the economic point of view there is no merit in including most repairs with production rather than with services, so that this enforced decision also is not unwelcome. Ship repairs were retained in the index as an exception because a large part of them represents very substantial work on reconversion, etc. ; the indicator available does not distinguish this from minor repair work, so it was a case of all or none.

We could find no short-period indicator for water supply, and as it represented nearly 1½ per cent. of the total net output covered by the 1935 census it is too large an item to retain within the formal scope of the index by pretending that it could be assumed to move with (say) output as a whole. One might, perhaps, say that it falls rather at the fringe of what one conceives as industrial production, having some affinity to a service, but there is no real doubt that an index of industrial production should have included it if possible. Its omission is unlikely, however, to affect seriously any of the trends in which most people are interested.

The most serious omission is undoubtedly the large part of civil engineering comprised by work in connection with roads, railways, gas, electricity, telephones, harbours, etc. So far as it is repair work, the remarks given above apply to some extent, though there would have been a good case for treating this type of repair like ship repairs and including it. For the omission of new construction, which represents a substantial part of the nation's capital expenditure and is far from stable, there is no justification except the absence of adequate information ; it seemed better to say frankly that it was excluded than to produce a bad index which ostensibly covered it.

Finally, one small point needs discussion, and that is the geographical area which is to be covered by the index. In principle our index relates to the United Kingdom, and the weights have been calculated on that basis. Some series which are used as indicators (e.g., the completions of houses) relate only to Great Britain and corresponding figures for Northern Ireland are not available. In these cases, however, Northern Ireland provides for so small a fraction of total production that it is unlikely that the movements would be significantly different if its output were included, especially as the factors causing changes in output are to some extent the same (e.g., timber supplies). Where production in Northern Ireland is important (e.g., in the linen and shipbuilding industries) the series used relate to the whole of the U.K.

CHAPTER 3

WHAT SHOULD THE INDEX MEASURE ?

After settling the " scope " of the index—i.e., what field it is to cover —the next question is what exactly one is going to measure within that field. What do we mean by the " production " of a period for this purpose ? And if there are alternative possible meanings (as there are), can we reconcile the need for a logical concept of production with that great decisive consideration, the nature of the data available ?

Once more this is a question of mutual adjustments, the concept being modified somewhat to fit the data, and the data being rearranged so as to give at least an approximate measure of a more logical concept.

Completions or Work Done ?

The first major point to grasp is that there are two distinct things which it might be useful for an index of industrial production to measure. The distinction may be seen most clearly by considering first a single industry, for which it might be useful to measure *either* the quantity of goods emerging from the industry in completed form in the period, *or* the amount of production which was done by the industry in the period, including any change of work-in-progress. Thus, if we were considering the building of houses, the first measure would relate to the number of houses completed in the period, whilst the second would measure the amount of work done in the period, covering any change in work-in-progress (positive or negative) as well as the number completed.

It is probably unnecessary to describe at length the respective uses of these two different concepts. To the users (or would-be users) of the product the first measure is the one which is most immediately relevant : recent history has shown only too clearly that the housing shortage is not relieved by getting a large number of houses started, or even advanced to the halfway stage. On a longer view, however, even the users will agree that the second measure is also relevant, and may perhaps eventually be more important.

To the industry itself the second measure is a more logical measure of its achievement in the period, and is more useful for estimating the total income earned by the workers and other factors of production engaged in it in respect of the period. Completions will, however, generally be more relevant to an estimate of the industry's actual receipts, unless there is a widespread system of progress payments, and there may be many purposes for which the more definite concept of completions will seem more appropriate. The normal accounting convention is that profits cannot be considered as accruing until a product has been completed (and sold).

Basis of Valuation

There is a further point which may usefully be discussed in terms of a single industry before we pass to the more complex problem of industry as a whole. Industries normally produce more than one product and it is clear that the only useful way of adding up (say) balloons, rubber boots and motor tyres to give the total output of the rubber industry in any period is on some basis of value. It might seem natural to say that one should value them on the basis of their selling prices in some period, but this raises two problems :—

(*a*) If we are to measure the movement of production in " real " terms presumably the same prices must be used for the periods to be compared, and there is no logical reason for regarding the prices of any one particular period as superior to those of any other.

(*b*) Is it really right to use selling prices at all for measuring output when the proportion of these which is represented by work done within the industry may vary enormously from one product to another ?

The first of these two problems may perhaps be dismissed rather summarily at this stage by a " practical " argument. If an index is to be calculated every month it is essential to adopt one set of prices and stick to it for a considerable period, whether or not it has any logical superiority over other sets. Moreover, this set must be decided when the index is started, so that the prices of the base year are an obvious choice. In our case this means 1946, and the effects of using that particular year's prices are discussed in Chapter 8 below. We may perhaps anticipate the main results here by saying that the choice is not likely to make any serious difference over a short number of years. If comparisons are made with pre-war, however, the matter is more serious ; the whole subject of pre-war comparisons is discussed in Chapter 9.

The second problem may be illustrated from the building industry. Temporary houses and permanent houses did not differ much in price in 1946, but a far greater proportion of the former's price represented work done in other industries. Should we really count them as virtually equal in arriving at the production of the building industry in each period ? Or should we take the part of the price which represented the work done by the building industry (the " net output content ") as our measure of value and so attribute more importance to a permanent house than a temporary ?

If it is completions or deliveries which we are measuring, there is something to be said on both sides. The user is concerned with what emerges from the industry and is not interested in how much of the work was done at some earlier stage ; this points to the use of " gross " values. The industry, on the other hand, wants a guide to what it has achieved, and for this the net output content is a better guide ; selling price is, of

course, the relevant one for estimates of gross receipts, which are often wanted, but net proceeds are on the whole more useful.

If, however, we are attempting to measure " production done in the period " rather than completions, it is quite clear that the net output content is the proper measure of value. We are then trying to measure what the building industry has accomplished in the period, and it would be stupid to go to the trouble of allowing for changes in work in progress if one were ignoring the fact that £1 million worth of temporary houses represented much less work done in the industry than £1 million of permanent ones.

Changes in Net Output Content

This discussion of net output content as representing the work done in the industry leads naturally to some highly intractable problems. Even if the building industry only produced permanent houses, and work in progress remained constant, there would be two major assumptions implicit in the statement that its production had doubled between two months because twice as many houses had been built in the second as in the first. The obvious one is that there has been no change in the average size and/or quality of the houses ; this type of problem is discussed in Chapter 5 below. The second, which we are concerned with here, is that there has been no change in the extent to which the building industry uses components, etc., which have been produced in other industries, rather than making the things itself.

Both of the above assumptions amount, in effect, to saying that on the average each house produced in the two periods represents the same " net output content " so far as the building industry is concerned (apart from changes in the price level, which we automatically eliminate). The average net output content might have increased because the average size of house was larger, or because the building industry was on the average carrying out much more of the work itself. Both of these results would, in fact, have happened between 1946 and 1948 if we had constructed an index for the building industry by counting permanent and temporary houses alike as " houses " ; the index would have shown far too small an increase.

In the case of a changeover to permanent from temporary houses the problem can easily be solved by treating them as two separate commodities. The same solution cannot, however, be adopted if the change is merely the incorporation of a greater number of prefabricated components, instead of making them on the site. We cannot expect the output statistics of houses to be subdivided according to all the possible arrangements in this respect.

So far as a monthly index of production is concerned we may simply say that no systematic correction for this sort of change in industrial technique (greater or less vertical integration) is possible. In a fair number of very important cases the problem is avoided because industries

are defined as covering certain stages of production (e.g., cotton spinning or weaving) and the output of the earlier stage (e.g., yarn) is recorded even if it is to be used in the same factory. But this procedure can only be applied to certain rather obvious cases, and in others the statistics of the intermediate products may relate only to those produced by the main industry, ignoring " self-suppliers."

Over fairly short periods there is probably some justification for the usual hope that this point will not make much difference so far as industry is concerned. The issue is very important in the case of agriculture, where the changing extents to which imported feeding-stuffs, fertilisers, tractor fuel, etc., have been used, call for very careful treatment if we are to get a proper measure of agricultural " production."* In industry there has been an obvious long-term upward bias in the results owing to the way in which many factories have ceased to produce their own electricity and drawn on the main supply ; their self-supply was not regarded as part of the output of either the electricity industry or their own, whereas the increased production by the outside suppliers is of course counted. When one is working with full annual data derived from a Census of Production it might be possible to allow for the varying nature of the *input* into an industry as well as its output;† but for a monthly index such refinements are impossible and (we may plausibly hope) would seldom be of importance.

Review of the Problem for a Single Industry

Having surveyed the various concepts which it might be useful to measure for a single industry, the constructor of the index has to make his choice in the light of two further considerations : the first is the inevitable one of the nature of the available data, and the second is the way in which the work on individual industries can be related to that needed for preparing an index for industry as a whole.

So far as the data are concerned, the most important point is that monthly output statistics nearly always relate to completions, with relatively little information about changes in work in progress. This is, of course, a very strong argument in favour of frankly saying that our index is to measure completions, which we have seen to be a useful concept. There is, however, a certain amount to be said on the other side.

In the first place, as is explained below, indices of completions by individual industries cannot be combined to give an index of completions by industry as a whole, if that concept is given its most natural meaning.

In the second, for a large number of industries changes in work-in-progress are seldom great enough to make any significant difference to the movements of the index-number, especially if this is averaged over several months, and the differences can hardly be *cumulative* over a substantial period ; it will often be reasonable to regard the index as

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* See Bibliography [1]. † See Bibliography [2].

quite a good measure of movements in " production " even though, in fact, it relates to completions.

Thirdly, in some of the cases where changes in work-in-progress are important (e.g., building and shipbuilding) there is enough information to make some allowance for them.

Fourthly, it is not always possible to get monthly statistics of *output* for an industry, and it is necessary to use other types of information as a measure of its activity. The most important of these are consumption of materials and employment, and clearly both are more closely connected with the *work done* in an industry than with the *goods completed.*

We may, therefore, leave this question of " completions *versus* work done " open for the moment. In a more normal period one might have adopted the traditional basis of work done and dismissed the problem of changes in work-in-progress as a relatively trifling, non-cumulative error which one eliminated in those industries where it was possible (e.g., building and shipbuilding), but otherwise ignored. In the post-war period, however, it seemed quite unjustified to pretend that the index was one of " production " in this way, more especially as its scope excluded finished munitions. In the engineering, motor and aircraft industries, for example, there was obviously a considerable difference between the volume of civilian goods completed in 1946 and the amount of work done on them : the aircraft firms in particular were devoting a large part of their (civilian) activity to increased work-in-progress (e.g., on the Brabazon I). With the achievement of reconversion, completions must then rise more rapidly than work done and so come into line. An index which purported to represent work done but was in fact based on completions would show far too steep a rise for these industries.

So far as concerns the other data which are required, the selling values in the base year would normally be available from the census of production ; the special problems arising out of the fact that a full census was not taken in 1946 are discussed in the chapter on weighting. The census does not show what proportion of the selling value represents net output content for individual products, but the use of the summary tables for the sub-divisions of the industry and general knowledge of the products will normally give sufficiently accurate data for the weighting to be done on net output content. We may conclude that the real problem is obtaining the relevant monthly data on output ; by comparison difficulties over weighting are relatively easy to overcome.

Completions by Industry as a Whole

When we pass on to consider industry as a whole some of the problems become rather different. So far as *completions* are concerned, the broad concept would most logically be a measure of the volume of goods which finally completed their passage through the industrial machine during that period. We would be interested in recording the number of shirts which have been completed, not the yarn or cloth which was produced

for making future shirts ; for industry as a whole, these are analogous to work-in-progress, even though they are completed so far as the spinner or weaver is concerned. We cannot, however, say that all intermediate products should be ignored, because some of them are exported, and others (e.g., fertilisers) are sold to producers who are not within the scope of the index ; in both cases these have completed their passage through the industrial machine as we define it. Anything transferred from one factory to another for further processing is, however, irrelevant, even if it might otherwise have been considered a " finished " product—e.g., sugar which is sold to the jam-maker.

If we ignore changes in stocks awaiting delivery this concept broadly means the volume of goods delivered to people *outside the field to which the index relates,** whether they be final consumers, wholesalers, retailers, farmers, foreign importers or whatnot. The nature of the goods is not the decisive test, as we can see from the exported yarn or the sugar sold to the jam-maker, but we can also think of the thing *roughly* as the completions of " finished " goods, plus exports of intermediate products.

This kind of concept is a perfectly logical and useful one, but unfortunately it presents great difficulties as a basis for an index. It cannot be built up from indices of completions prepared for individual industries, since these will be based on their total output, and we must eliminate that part which is passed on to other industries for further processing. Strictly speaking, this means that we need the output statistics for almost everything (since even the crudest intermediate products may be exported, or possibly sold to farmers, etc.) together with the proportion of each product to be eliminated to avoid duplication, and this proportion might vary from month to month. A very rough approximation might be obtained, however, by dividing commodities into two classes : " unfinished," in which the only substantial deliveries to people outside the scope of the index consist of exports, and " finished," for which we must include some internal sales. For the former class we would not use output statistics at all, but would work from the monthly export figures ; for the latter we would use the output statistics, and assume that a constant proportion had to be deducted in each case, unless we had special information on the subject (as we do with coal, for example). The proportion to be deducted would, of course, frequently be nought, where the goods were not used at all for further processing within the field covered by the index.

The commodities might be weighted by their selling value at the factory, or a deduction might be made for the imported and agricultural materials used in them—the issue is similar to that discussed above for a single industry, where some case can be made out either for selling value or for net output content. When we are dealing with industry as a whole the " net output content " must of course cover all the stages of

* Sales of *capital* goods (e.g., machinery) to firms within the scope of the index are also included.

production, including, for example, the production of electricity, so that we only need to deduct the things purchased from outside the field covered by the index.

No attempt has been made to construct an index of completions in this way, but it is a field that might be worth exploring. A major difficulty is that output statistics are generally far worse for finished goods (where they would be needed) than for unfinished.

Production by Industry as a Whole

If we are concerned with " production " or " work done " in a period, rather than with completions or deliveries, then the logical problem of combining the indices for individual industries is a simple one. It does not matter whether the industry was producing final goods or intermediate goods, or whether the goods were all completed in the period, or went to swell its work in progress : whatever counts as production for an individual industry counts as production for industry as a whole, and we simply add it all up on the basis of its net output content. In effect, where a product passes through more than one industry during the process of its manufacture, each stage will be given a value based on the net output content of that stage ; we build up the total net output represented by a shirt by counting a certain amount for the work of spinning the yarn, another amount for weaving, another for finishing, another for making-up, and a whole host of small amounts for making the minor materials used at all stages (buttons, electricity, etc.).

If there were no change in work in progress at any stage the contribution to the total index arrived at by measuring output at all these stages and adding up would be the same as that obtained for the " completions " index by watching the output of shirts alone ; but we would not be able to demonstrate this fact, because the output of yarn, etc., for shirt-making would not be recorded separately from that for other uses, or for export. " Completions " analyse the total output according to the products which emerge, giving each its full value irrespective of the industry in which this accrued ; " production " analyses the total output according to the *industries* in which the value is added, irrespective of whether the products are finished in that industry or not, or of the use to which they are put.

The Practical Outcome

It will be seen from the above discussion that the constructor of an index is faced with a nasty dilemma. The traditional concept has been that which we have called " production " or " work done." Here the difficulty is to construct appropriate index-numbers for the individual industries when so much of the data relate only to completions or deliveries : if we could get over this obstacle, the " parts " could easily be put together to make a logical whole. If, on the other hand, we

choose completions as our basis, we can produce the indices for individual industries, but these are not what we really want for making an index for industry as a whole.

In the face of this *impasse* it is natural to consider what would be the result of following the easy course of combining indices of deliveries by individual industries as though they were indices of work done. Does the resulting hybrid represent anything which is useful, even as an approximation?

Fortunately, the answer seems to be that it does, provided that in using it we remember what its basis really is. We must use net output as the basis of weighting for combining the various industries, as well as for combining the products within an industry. We can then think of the index in three different ways :—

(*a*) As an approximation to an index of work done, remembering that it will give too *high* a result when comparing periods in which the volume of work in progress is fairly stable with ones (such as 1946) when it was rising.

(*b*) As an approximation to an index of completions in the sense discussed above, remembering that it will give too *low* a result when comparing " stable " periods with ones in which the finishing industries were buying intermediate products (e.g., bricks) faster than they were delivering the equivalent finished goods (e.g., houses).

(*c*) As an actual index of completions from the point of view of the industrialists ; the brickmaker regards his job as completed when he has delivered the bricks, and this is important from several points of view. Thus, his accountant will tell him that he can take credit for the profit, whereas he could take none for increased work in progress (half-baked clay, etc.) ; his banker will be quite content to credit him with the proceeds of the builder's cheque, even though nothing has actually been delivered to the final consumer.

In considering the first two of these concepts, it may be helpful to examine what the index in fact does in relation to an article which passes through several stages of production. One may think of its final value as made up of the imported raw materials and successive amounts added by the various industries (the " net output content " for those stages). The index measures the rate at which goods are passing the landmarks on the way to completion represented by transference from one industry to the next, or by the final industry to the outside buyer. For each article passing one of these landmarks a number is entered in the scorebook representing the length of the stage just covered (the net output content), but no account is taken of the fact that a period may close with a far larger number of articles approaching the end of a stage than there were at its opening (*cf.* the unfinished houses).

If all rates of flow were steady, the index would measure both work done and completions, in the sense discussed above. Under any other circumstances it does not properly measure completions because it only enters part of the value of each article in the scorebook as it passes the finishing post (the net output content of the last stage) ; the parts represented by earlier stages are multiplied by the numbers of articles passing the landmarks at the end of them, not the number passing the finishing post.

A proper measurement of work done would, of course, require that account were taken of the flow at *all* points, and not merely at the ends of the stages. In so far as we want to use the index as an approximate indicator of work done, it is obviously right to base it wherever possible on series which reflect this more closely than deliveries can, and for that reason an alternative " B " calculation has been made on that basis in the case of building and shipbuilding. These alternative figures have also been used to produce a " B " series for the aggregate index ; this naturally shows a smaller rise between 1946 and 1948, but still exaggerates the increase in work done, because no correction could be made for engineering, vehicles etc.*

Finally, one point may be noted here in advance of the fuller discussion in Chapter 7. If we are, in fact, going to use completions as our indicator of movements in an industry's output, then the weight given to that industry must be the net output corresponding with the goods completed in 1946, *without* any allowance for increased work in progress. This is true even if we are wanting to use the index as an approximate measure of changes in work done, since otherwise the unduly big percentage rise obtained for (say) engineering between 1946 and later years will lead to its being permanently overweighted.

* Our A index shows over this period too small a rise as a measure of completions ; our B index shows too large a rise as a measure of work in progress.

CHAPTER 4

PRINCIPLES FOR SELECTING INDICATORS

We concluded in the previous chapter that our basic concept of what we wanted to measure for each industry was the volume of goods completed in the period. The next problem is to choose the series for each industry which are to be used to measure this from month to month.

In making our selection we have to keep certain practical limitations in mind. The index is to be calculated every month, and its usefulness is much affected by the speed with which it appears, quite apart from any question of labour or expense. One must, therefore, try to balance the increased accuracy to be obtained by using (say) eight types of sports goods instead of five to represent the output of that industry, against the increased time and work needed to prepare the index.

It would be possible to produce formal rules for use in this connection, but they would be difficult to apply in practice, mainly because of the lack of data which really show how likely it is that the output of the various articles will move differently *in future*. This is, of course, the key factor in determining the *percentage* errors which may be expected in using the two possible sets of articles ; the *absolute* effect on the index depends both on this percentage and on how large the net output of the industry was in the base year. The extra amount of work and delay involved depends on all sorts of practical issues, such as whether the statistics can reasonably be relied upon to appear on a consistent basis, at convenient times and in a convenient document. The job of the selection committee is to make a rough assessment of the balance of these rather imponderable factors, and their decisions are bound to be based partly on intuition ; the important thing is to remember that it is differences in future movement which matter, and that the weight of the industry (or section) is just as important as the percentage error in determining *how much* they matter.*

The Need to Accept Second-rate Indicators

It would, however, be wrong to think of the selection committee as continually holding a balance between the enthusiasm of the perfectionist who wants to include endless series, and the caution of the chief computor and the establishment officer, who are anxious to limit the work. For a great many industries there is not, even now, an embarrassing wealth of output statistics from which to choose : it is rather a question of deciding which of the scraps of information that throw *some* light on the industry's activity would provide the least unsatisfactory indicator of its output. This quite frequently means that one has to use a series which does not

* See Chapter 11 for some cases where our intuition let us down.

directly relate to output at all, but perhaps to materials consumed or employment.

The characteristics of the various types of indicator are discussed systematically in the next chapter. It is important to deal here with the preliminary point, whether it is really right to use these indicators which do not relate to " production," or whether it would not be better to omit the awkward industries from the calculation in some way and confine it to those for which genuine output series are available. The discussion may usefully be extended a little to sketch the principles involved in deciding when to use these indicators, and how to select them.

We have already seen in Chapter 2 that it is perfectly legitimate, and indeed sensible, to omit certain awkward industries by defining the scope of the index as excluding them. If, however, one is not prepared to define the index as excluding them, there is no escape from making *some* assumption about the movements in their output : we may not do it explicitly, and we may prefer to make one big assumption about all the awkward industries collectively rather than consider them individually, but we cannot dodge the problem. So-called " complete " omission of the industry from the calculations means assuming that its output (together with that of other omitted industries) will move with the index for output of all the other industries.

If we are faced with a single " awkward " industry the issue is therefore relatively simple in principle, even if more difficult to decide in practice : we have to choose that series, or combination of series, which will give the best representation of movements in this industry's output. Is it likely, for example, that movements in the output of the industry will be more similar to those in its numbers employed, or its consumption of some material, or the output index for other industries in the group, or output as a whole ? And can we make some rough adjustments to the chosen series to increase the similarity ?

Unfortunately, however, we are not faced with a single awkward industry, and before considering how this kind of issue can be tackled it is necessary to examine the argument that one would get a better index by *not* tackling it industry by industry, but rather by taking all the " awkward " industries together, and assuming that movements in their output would be similar to those in the industries for which we have good data. It seems plausible to argue that although the ingenious use of second-rate data would give the best estimates for each awkward industry considered by itself, yet the index as a whole would actually suffer from all this ingenuity. Why not assume that the awkward industries taken together constitute a fair sample of all industry, so that their output will broadly move in the same way ? After all, one might say, there is no obvious reason why the movements in an industry's output should be correlated with the presence or absence of good data about it, and the single big assumption avoids introducing a vast number of possible errors into the index by using dubious data, which do not really relate to production at all.

This is not a very easy question to analyse scientifically, because so much depends on the skill with which the selection committee makes its subjective decisions about " what may reasonably be assumed to move with what." There are, however, a number of fairly definite points which can be made.

First, even if the " one big assumption " did give a better index for industry as a whole, thanks to cancelling of errors, it would make great difficulties for any subsidiary indices covering a smaller field. There is no reason whatever for assuming that those awkward industries which fall in a particular group will show movements similar to industry as a whole, so that clearly we cannot include them in the group calculation on that basis. Nor would it be plausible to calculate group index-numbers on the basis of those industries in it for which " good " series exist : there may be only one or two " awkward " industries in it, which could not possibly be considered a fair sample, and yet these might be fairly big ones. There can be little doubt that if we want to have good group indices we must make our best estimate for each industry, even if it is a rather poor one. Our best estimate may be that it will move with the rest of the group, but there will usually be data which enable us to do better than that.

Secondly, the one big assumption must largely remain an act of faith, even for industry as a whole. We can derive no scientific support for it from the theory of sampling, because the industries for which " good " information exists do not constitute a scientific sample. This statement does not imply, of course, that the Government departments, trade associations and other bodies who collect the primary data on output deliberately select those industries where a rise (or fall) is to be expected ; there is no need to adduce *deliberate* bias in support of the thesis that a sample is not " random " or " representative " in the scientific sense. We can, in this case, point to an obvious danger of unconscious bias in favour of basic and semi-monopolistic industries, simply because it is so much easier to collect information about their output than it is for (say) fancy goods or clothing. This is particularly serious when the index covers a period when industry has been distorted by war, since the " awkward " consumer goods industries were deliberately contracted ; it renders useless any appeal to " experience," based on the movement between pre-war censuses of production.

Even apart from this specific danger one is bound to feel rather uneasy about relying on a sample of industries of this arbitrary character. Suppose some trade association had decided to cover (or not to cover) some large industry with a very untypical movement : the assumption would still have to be that the uncovered industries moved with the others, no matter in which group this one were included. Moreover, it also leads to the sort of dilemma that we considered in Chapter 2 over rearmament : does the index based on " good " series measure movements in industrial production *including* or *excluding* (say) repair work, or public works contracting, or even finished munitions ? The apparently objective

principle of defining a field and including in the calculations all those parts for which " good " series are available will lead to the same answer whether or not we include any of the above in our definition ; yet clearly there will be many periods (e.g., after a cut in munitions and public works) when the answer cannot be right for all definitions, even if it is the best that can be produced by strictly objective methods. The definitions would all be reasonable ones to take, and one can only go further by considering whether the movement based on the good series is more likely to apply to the awkward industries with or without the inclusion of (say) repair work ; this is, to put it mildly, a formidable task.

Thirdly, and more constructively, it is clear that the important point in making our " dubious " estimates for the individual industries is to avoid *systematic* errors. So long as the errors are not biased in one direction, their very number will largely justify the bit-by-bit procedure. We can call into play the argument about cancelling of errors which was really the basis for the one big assumption, and we shall have more scientific justification for it, unless the individual errors are liable to be quite ridiculously large. In choosing indicators which will broadly " move with " the output of each industry, our major objective is to minimise the likely error in each case, but we must also try to avoid consistently choosing indicators which will be too optimistic (or pessimistic) under circumstances which are likely to arise. If a number of our basic series are liable to common errors of this type we must try to correct for them even if the adjustments are rather arbitrary. Thus, if we use " numbers employed " in the industry on any extensive scale as a measure of output, we must be ready to correct for changes in hours worked, especially if there is a *general* movement towards shorter or longer hours ; as a special instance of this, a correction is regularly needed in months containing holidays, since otherwise the industries for which we use numbers employed as an indicator would all fail to show the drop in output which is a marked feature of the production data for other industries. Our correction may not be exactly right, since the facts vary from industry to industry, and are not fully known, but a reasonable attempt to allow for this factor should leave some errors in each direction, whereas otherwise they would all tend to be one way. Similarly, a special correction must be made for a major general factor such as the fuel crisis, and over a long period we must be prepared to make a rough correction for changes in productivity, should other industries show that there is a general trend.

Without arguing the point at greater length, we may perhaps conclude that the right procedure really is to break the problem up into its parts, and produce our " best " estimate for each industry, whilst keeping a special watch on the danger of systematic errors. This does not, of course, preclude assuming that a certain industry will move with a particular group, or with output as a whole, if that seems to be the best assumption to make ; this point is discussed further below. Moreover, we must be on the look-out for cases where it is easier to find an indicator

which will reflect two or more industries taken together than it would be to deal with them separately. We do not get rid of errors which are large in absolute size merely by having a lot of them, so that there is no virtue in splitting up a sector of production into its elements if the likely error in one of the parts would exceed the likely error for the entire sector, if this were measured as a whole. This type of case arises more often than one might expect, especially where employment figures are available for a Ministry of Labour category which covers several census trades, or where the supply of a certain material can be taken as representing activity in two or three consuming industries taken together. Even if there is a good indicator for one of the constituent industries, there may be nothing at all reasonable for the other(s), so that even a moderate combined indicator may give the best result for the sector as a whole.

Specific versus **General Indicators**

The next question is how to decide what *will* give the best reflection of an industry's output when one has a choice of various indicators, none of which is just what one wants. It might seem attractive to say that the rival candidates should be tested with the aid of the censuses of production, but we frankly did not attempt this. Quite apart from the work involved there is the objection mentioned above, that post-war relationships are likely to be very different. Furthermore, the censuses can only test the accuracy of the indicator at measuring movements in the *annual* output over a longish interval, whereas we are concerned with the different problem of short-period movements ; thus, the objection to the use of employment as an indicator because productivity may change cumulatively is far more serious if we are making long-range comparisons.

Our decisions necessarily varied from case to case, and had to take account of the reliability of the possible indicator itself, as well as its suitability for measuring the output of the industry in question. In general, however, we preferred to rely on " functional " connections between the industry and its indicator rather than on general presumptions that the same forces which caused the indicator to move would also act on the industry's output. This point may be illustrated by two examples.

First, hats and caps. Here we had no series which directly indicated the activity of the industry in any way except employment, but one might perhaps argue that its output would probably move with that of other clothing, because the same broad forces affect them both. We preferred to start from the specific indicator, numbers employed, because this had a direct functional connection with the output, and the scope for errors was then limited to the fairly concrete factor of variations in output per head. We narrowed this down further by assuming a fall in months containing holidays, and as a special measure we also assumed a fall in the fuel crisis of February-March, 1947, based on the movement in industries which were similarly affected by it. If it seems worth while we can make periodic adjustments for changes in the average hours worked and

for any marked trend in productivity which may be revealed by output statistics of other industries.

The alternative course of assuming that the output would move with that of other clothing would make no use of any data relating directly to the hat and cap industry, and there is no way of setting any limit to the possible error. Hazardous adjustments would probably be needed when rationing changes were made, and altogether the assumption of " common forces " is a great act of faith in disturbed times.

There is the additional point that the figures for other clothing are themselves far from good, so that this assumption would incidentally *repeat* the same errors—a thing we wish to avoid if we want the inevitable errors to cancel out as far as possible. By contrast, the employment statistics are fairly accurate, and their errors are quite uncorrelated with those in other series used.

The second example, fish curing, is a much more debatable one, and is deliberately chosen to illustrate the issues involved for a marginal case. This is a small trade with a highly variable output for which no statistics are published. There are not even any employment statistics which in the least reflect its movements, because the Ministry of Labour lump it into a large omnibus category called Other Food Industries. To scrap the information which was available for many of the other constituents of this hotchpotch and use a single employment figure for the whole of them would be to let the tail wag the dog. What then should one do ?

The purist's answer to this question is to say that the scope of the index should be defined as excluding fish curing as well as finished munitions, repair work, etc. ; but too much purism leads to rather useless results for the reasons explained in Chapter 7, and we rejected this course.

The typical pre-war index would almost certainly have given the industry's weight to the food group, and so assumed that the output of fish curing moved with that of bread, biscuits, sugar, etc. This seemed to us fantastically wrong, both seasonally and from year to year.

Our own general rule when we could see no reason for considering that the output of an industry would move even *very* broadly with any available series was to assume that it would move with *output as a whole* —i.e., in effect to leave it out of the calculations, though retaining it nominally within the scope of the index as a whole (but not any subsidiary group index). We were, however, reluctant to treat fish curing in this way, because it is so obviously *not* a typical industry, and even a very dubious indicator which was functionally connected with it to some extent seemed better than nothing. Moreover, fish curing ought to be included in the subsidiary index for the food group if at all possible.

The only available series which we could find were the weight of fish landed and the exports of cured or salted herrings. The latter represented a very substantial part of the industry's output in pre-war days, and it seemed the best choice for our comparison between 1935 and 1946 (see Chapter 9), but there were two objections to its adoption for the main month-to-month series : the proportion of output exported may change

greatly in future, and the seasonal factor is quite different for production and for export. After considerable hesitation, therefore, we selected the weight of fish landed as the least unsatisfactory indicator available : admittedly the proportion cured may vary greatly from month to month, or even year to year, but there seemed a better chance of being near the truth with this series than with any other. Moreover, there is no reason to suppose that the error will be correlated with that in any other series, and its absolute size cannot be very large.*

Problems within an Industry

We have so far been discussing the matter as though each industry were a single entity, for the output of which we either had or had not information, and which would have a single indicator. This is, however, a great over-simplification of the problem. Nearly all the industries as defined for census purposes produce a great variety of products, and the more normal state of affairs is that we have information about some of these, but not about others ; or we may have other information reflecting part of its activity such as materials consumed, but nothing for the rest. We must now consider the problems raised by this awkward fact.

From a strictly logical point of view the position is clear. The grouping of different productive activities into " industries " is irrelevant to the analysis : it is well known that the grouping can be done in many different ways and logically we ought not to have introduced this concept into the discussion at all. Whatever has been said so far about " industries " should have referred to sub-sections of industries, or more strictly to particular productive activities. The index-maker should consider each one of these separately, and decide what indicator will represent it best—perhaps an actual output series, if there is one, perhaps something else. He may, of course, decide that a single indicator will reflect the combined movement of a number of these activities better than a set of separate ones would, in the way discussed on page 21 above ; furthermore, the grouping for this purpose may, in fact, correspond with one of the industries as defined for census purposes ; but the principle of reducing the problem to its elements means going far below the level of an " industry."

There is no escape from this argument, and we did, in fact, consider each industry in detail unless there was a single indicator which satisfactorily covered the whole of its activity. This was quite frequently the

* Another marginal case for which this statement provides some justification is the use of the consumption of oilcake and meal as an indicator for the cattle, dog and poultry food trade. This seemed slightly better than assuming its output to move with output as a whole (the only apparent alternative) because the governing factor seems likely to be the supply of materials, and the series chosen broadly reflects this.

case, and in other instances the industry could be readily divided into sections, for each of which there was a comprehensive indicator. The problems became really acute when there was information for some products but not for others. Strictly speaking, there is no reason whatever for automatically assuming that the output of the " missing " products will move with that of the others, or with some combination of them, merely because they are classified to the same industry : the point is exactly the same as the one which we discussed about an industry and its group—we may after examination decide that this is the best assumption we can make, but there should be nothing automatic about it. Furthermore, there is equally no reason for assuming that the best way of using the data which are available for some products to represent the missing items will always be to combine them in accordance with their own net output content, or value, or tonnage, or any other automatic criterion.

Having said so much, however, we must add that it is almost impossible in practice to avoid adopting the attitude that the products of a particular industry for which information is available will be regarded as a " fair sample " for that industry " unless there are obvious reasons to the contrary," or " unless there is some obviously better alternative." The driving force is in the last part of the sentence. Even if, for example, a conscientious member of the selection committee says that there *are* obvious reasons against assuming that rubber tyres, rubber boots and rubber belting can be taken as a fair sample of the rubber industry as a whole, since the other products range over such unrelated fields as surgical goods and rubber toys, he may find it very hard to suggest an alternative procedure. If he is posing as a purist he should say that the scope of the index must be redefined to exclude the awkward goods, but that line will lead to absurd results if adopted too freely. More reasonably, he may say that they should be taken out of the rubber group and be assumed to move with output as a whole like gold refining ; in this particular instance a good case could be made for such action, but it is not a course which one wants to adopt very frequently. There is a strong temptation to argue that the uncovered part of the field has at least one thing in common with the rest—its dependence on the supply of rubber—and that at least for part of the time this factor was very important. Moreover, we can apply the general argument in favour of treating an industry as a unit, despite the heterogeneity of its products, that its sections usually employ the same kind of labour, and so are likely to be similarly affected by such things as strikes and labour shortages. A still uneasy conscience may perhaps be quietened a bit more by the arguments that it is hard to see any reason why output should rise more in either one section or the other, and that the indicators used covered more than half the total.

It must be freely admitted that there is a good deal of special pleading in these arguments. The fundamental difficulty is the old one, that there are not really enough data to *measure* total output, and that we can only " hope " that the devices used to fill the gaps will lead to a reasonable result. Since the work of preparing an index inevitably starts from the

tables for industries given in the census of production reports, it is not unreasonable to fill in the gaps by " hopes " which fit in naturally with the work, unless there is a strong reason for saying that some other method would give better results. The use of census industries as units may reasonably be given the benefit of the doubt.

The above " presumption " must not, however, be taken as implying that the movement for a census of production industry should be based solely on the products within it for which " good " data are available. If there is another section of the industry for which an indifferent indicator is available, all the earlier arguments in favour of breaking the estimate up will apply, unless there is some definite reason for assuming the outputs of the sections to move together. To take an example, the only section of the grain-milling trade for which good data are available is wheat-milling. There is, however, a series for the total disposals of maize, which showed that in 1946 very little maize was available either for milling or any other purpose. Since 1946 the supply of maize has increased substantially, though it is still well below pre-war levels. To give the whole weight for the trade to wheat milling is tantamount to assuming that the milling of maize would be more or less stable, which is obviously wrong. The particular rise shown by the series for total disposals may not strictly apply to the part that is milled, but it is obviously a better indicator for this section than the amount of wheat milled.

A more debatable example of this need to consider the missing sub-divisions carefully is provided by the drugs and medicines section of the chemicals trade. In this case our indicators essentially all referred to heavy chemicals, and could not really be considered to be related to the drugs section at all. The latter was, however, a very large one—bigger than many separate industries—and we felt that it could not possibly be covered by the general presumption in favour of treating industries as units. After much heart-searching we decided provisionally that we could invent a better series for the trade on the basis of such general indications as the movement of sales by retail chemists, the export figures and the general nature of the trade. This is a matter on which we hope to improve our provisional figures with the aid of trade advice, but the point of principle is that in an important case like this even so dubious a " direct " indicator of the section as our " notional series " seemed preferable to relying on a general presumption that its output would move with that of (say) heavy chemicals, or output as a whole.

Finally, there were some cases where it was clearly undesirable to keep within the framework of a census industry. The preserved foods trade provides a good example. This is really an agglomeration of different activities, and our data only covered jam and breakfast cereals—about one-fifth of the trade, and not a particularly representative part at that. After much deliberation we decided that the main characteristic of the missing part was that it covered " secondary " manufactured foods, and that the best course was to assume that its output would move

with that of a wide group of other secondary foods for which we had statistics, and we accordingly spread its weight over four other census trades as well as the part for which we had statistics. The main arguments in favour of this were that in times of shortage the trades would depend on allocations of the same broad types of basic foodstuffs (sugar, fats, meat, etc.) and would probably receive broadly similar treatment ; whilst in more normal times the demand factor would operate similarly on them.

CHAPTER 5

THE FOUR TYPES OF INDICATOR

So far we have not considered at any length the types of indicator used to represent the movements in the output of the various industries. A full list is given in Part II of those used for each industry, and the object of this chapter is to consider the characteristics of the various types, and the implied assumptions which are made when they are used to measure changes in an industry's output.

Production in Physical Units

The type of indicator which is normally considered best, and which, in fact, covers 60 per cent. of the weight of our index, is a record of the physical quantities of the principal goods produced (i.e., as a rule "completed" or sometimes "delivered") by the industry. Under present circumstances it is probably right that this indicator should be used wherever possible, but its reputation is not really so well deserved as it might appear, and it is important to appreciate its limitations.

The *advantages* of this kind of indicator are obvious. It relates directly to what we want to measure (subject only to the questions discussed in Chapter 3 about changes in work-in-progress and net output content), and it requires no correction for price movements. There is no need to labour this side of the balance sheet.

The trouble really arises out of two facts: most industries produce a large number of different products, and most products vary considerably in quality. It is conceivably possible that information might be collected every month about the output in physical terms of every single one of the products, though the work involved would be phenomenal; it is in the nature of the case impossible, even theoretically, for the statistics for each of these products to be subdivided into all the possible "qualities," because in most industries there is no recognised system of grading.

These two sources of difficulty are, from an analytical point of view, largely the same. For a strictly accurate assessment of movements in output we would need details for each "item" which had a different net output content in the base year; an "item" for this purpose might be a different product (say, a cricket bat instead of a tennis racquet), but it might equally well be a different quality of the same product (a tournament racquet instead of a beginner's type). Indeed, it is notoriously difficult to say what we mean by a commodity or product, and it might be considered equally legitimate to treat (say) a bespoke suit and a ready-made one as two different products or as two qualities of the same one.

From the point of view of the index-maker the important points are that strictly speaking we ought to have separate statistics for a vast

number of " items " or " headings " ; that we *might* be able to get particulars of output under certain headings (whether we call these different products or distinguishable types) ; but that quality is not normally a definable characteristic for statistical purposes, and so cannot feature as such in the titles of the headings. Perhaps one ought to add that if we had everything that is theoretically necessary for every industry the labour of compiling a perfect monthly index would be so formidable that we would certainly not attempt it.

What then are the consequences of using data about production in physical terms which do not comply with the very exacting theoretical requirements ? There are really two distinct sources of error : *inadequate analysis* and *incomplete coverage* of all the various products.

The first of these, inadequate analysis, may be illustrated from the iron and steel foundry trade. Here our indicator is the total tonnage of iron castings delivered, and it may be regarded as " covering " almost everything which the trade produces. It is not, however, broken down in any way, so that a ton of iron pipes (which has a very low net output content) counts equally with a ton of the most intricate engineering castings ; and, of course, there is no attempt to distinguish high-grade pipes from those which only just escape being remelted. It follows from this that our indicator will only give a true measure of movements in the industry's output if the composition of this remains stable, or if the changes cancel one another out ; more strictly, the average net output content per ton (measured at base year prices) must remain constant. There will be serious errors if the proportion of " simple " castings rises—as it may well do when building activity is increasing, since a large part of the demand for simple castings depends directly or indirectly on the building and civil engineering industry.

The risk of errors would be reduced if there were separate monthly figures for different broad types of castings, such as are published annually by the British Iron and Steel Federation. Ideally, of course, we would like a classification based mainly on value (more strictly, net output content), but the split by types does, in fact, serve to divide roughly the cheap from the more expensive, and was used for our comparison with 1935. It still leaves, of course, the danger that the average quality may have changed within the broad type, but in this particular industry that may not be very serious ; in others (e.g., boots and shoes) this " quality shift " within a category can be a formidable matter, even though we have separate statistics for a number of types (men's, women's, etc.).

The second problem, incomplete coverage of products, is well exemplified by the chemicals trade. Here the number of different products is legion, and for a vast number of them no monthly statistics are available. It might theoretically be possible to record the total weight of all chemicals delivered each month, in the same way as for iron castings, and so obtain a " comprehensive " series ; but the objections to adding together penicillin and washing soda on a weight-for-weight basis are even greater than those with pipes and machinery parts, and the plain

fact is that such a series does not exist. We are forced, therefore, to use statistics for a selection of products or product groups (e.g., synthetic dyestuffs), despite the obvious danger that our selection will not, in fact, show the same movement in output as the trade taken as a whole.

It is impossible to deal at any length here with the question whether this danger is likely to be a really serious one, and if so, under what circumstances. There is one important point which needs to be made : any new product, which is developed after the index is started, has no chance of being selected, and to that extent the index is biassed downwards. Apart from this, it is theoretically conceivable that an index might be based on a scientific sample of the goods produced in the base year *if one could arrange for information to be collected for all the items which were selected ;* one must, however, be under no illusion as to the large number of products which would have to be included in the sample, and the consequent volume of work for all concerned, including the compilers of the index.

As yet the above sort of technique has not been applied, and our selection was necessarily confined to that part of the field for which data were already being collected. Moreover, we were very much influenced by the need to keep the volume of work within manageable limits. In the case of chemicals this meant that if we were to cover even a moderate proportion of the trade our choice had to be mainly based on the unscientific principle of taking those products which had the largest value of output. Such a procedure is likely to lead to a downward bias in the index, because it concentrates the sample on to the staple, basic chemicals. In a progressive industry it is likely that the output of these will expand less than that of more complex products, even if we could ignore the completely new developments which had no chance of being included in the sample. This source of cumulative error only becomes really acute, however, if the index runs for a fair number of years, and to try to avoid it by adding further series would have required an enormous increase in the volume of work both for us and for the suppliers of our information. As an interim measure, therefore, we followed the line of least resistance ; with the co-operation of experts in the trade we hope to investigate the possibilities of a different technique (see pages 31-34), based on a comprehensive value figure.

Conclusions about " Physical " Series

The conclusions which emerge from this study of the use of physical quantities produced as an indicator may be summarised thus. It has obvious advantages, but in a great many cases it will only give really satisfactory results at the cost of a vast amount of work both for the suppliers of the basic information and for the compilers of the index. The essential reason for this is that the output of most industries is highly complex, and can only be satisfactorily recorded in physical terms if it is divided into a great many separate headings ; indeed, the amount of

sub-division which is really required will often be impossible, even in theory, because of our inability to define quality, and however many sub-divisions we use our results may always be upset by a shift in the average quality* represented by one physical unit of a particular statistical category. If we do not sub-divide the output at all, but simply measure it all in tons or square yards, or some other all-embracing unit, we are implicitly assuming that shifts between different types can be ignored. In so far as the whole output is not covered by the index, whether through lack of basic data or to save work, there is the further implied assumption that the commodities selected will prove to be a representative sample so far as the movement of their output goes.

One would like to add something positive about the direction and size of the error which is likely to arise from these causes, both in general and over the particular period covered by our index. Unfortunately it is extremely difficult to say anything very concrete, apart from re-emphasising the general tendency for a non-comprehensive list of products to give the index a long-term downward bias.

It is clear, of course, that the danger of errors is particularly great in disturbed times, when output is changing back from its war-time pattern to a more normal one. This means firstly that the composition of such generic headings as " tons of iron castings " may be altering greatly from high- to low-value products (or vice versa) ; secondly, that there may be shifts in the average quality of the more specific products as style restrictions, for example, are relaxed ; and thirdly, that the individual products of an industry may show very divergent movements, with consequent dangers if only a sample of them is used. But these factors (fortunately) do not all tell the same way, so that we can do little more than point to the general risk of error in a transition period, without even being quite positive about its direction. It is perhaps true that the " quality shift " for specific products is likely to be upwards on the whole, and the " samples " of products used as indicators for particular industries may tend to exclude those non-essentials which were not produced during the war, and the output of which has therefore risen exceptionally steeply. Both these tendencies would make the index show too small a rise, but there are possible exceptions to each of them. Thus, relaxation of rationing may have reversed the public's tendency to insist on something better than the cheapest types, and so lowered the average quality for those goods ; and the products omitted from an industry's sample will often have included abnormal goods produced for the Forces or to meet war-time conditions, the output of which has rapidly declined.

When we turn to consider the third of the factors it is clear that post-war shifts in the composition of aggregates such as iron castings or even cotton cloth may either raise or lower the average net output content per physical unit. Thus, the figures for cotton cloth cover a multitude of what are fundamentally different products, in the sense that they serve

* More strictly, " net output content at base-year prices."

quite different purposes—e.g., tyre canvas, sheeting, dress material, " native " cloths for the export market—and these may well have very different net output contents. The post-war period has doubtless seen a great shift in the proportions of these within the total, but there is no way of saying *a priori* whether the net effect will be towards those with a higher or a lower net output content.

On the whole, it is our impression that the net effect of the three factors is to cause parts of our index which are based on physical quantities produced to show too small a rise between (say) 1946 and 1948, mainly because of a general tendency to raise the average quality of goods. If the index were continued unchanged for ten years the omission of new products which did not fall within one of the generic headings would almost certainly produce too low a figure.* When an index is based on production in physical terms of a sample of products it is particularly necessary to revise it frequently in the light of comprehensive census information.

Finally, two small points are of sufficient interest to deserve brief mention. The first is that for index purposes a rise in the average " quality " of an industry's product is relevant if it reflects a rise in net output content, but not if it reflects the use of more materials per unit of product. This was particularly relevant to the consideration of the brewing industry, where output might have been measured in bulk barrels or standard barrels. We were informed that a higher alcohol content mainly reflected the use of more materials, and made little difference to the work of the brewing industry, so that the bulk barrel was the appropriate unit. In so far as the extra materials are industrial products (e.g., sugar) their output would be counted there ; otherwise, it was not right to give industry any credit for them, or for the resulting alcohol.

The second also emphasises the dominating importance of net output content. It is legitimate to save work by adding together figures for any types of products, however dissimilar, provided that they have broadly the same net output content per unit ; as an extreme example we added together the figures for two types of electrical machinery, even though one was measured in B.H.P. and the other in K.W., because this appeared to be true.

Deflated Value of Production

The second type of indicator is based on the *value* of the goods produced by the industry in the period, and has been used to cover 12 per cent. of the weight of the index. This type has the merit of providing a single figure to cover a possibly large and varied assortment of goods, for which there would have to be a correspondingly large number of

* But see the discussion in Chapter 9 about the tendency for indices which use base-year prices for valuation purposes to show a bigger rise than those using the prices of the final year.

separate series if the output were recorded in physical terms ; moreover, it is a kind of figure which can usually be given fairly easily by the producers, since it fits in with their normal records. It requires, however, to be corrected for price changes before it can be used in the index, and with the present inadequate supply of information about price movements of manufactured goods this is a serious drawback.

It is useful to consider the consequences of using this type of indicator, since the best way to improve an index of production is probably to use it for industries which have a very heterogeneous output, concentrating the energy of the collectors of basic data on to the preparation of appropriate price indices. The two principal items on the credit side, apart from convenience, are as follows :—

Firstly, the value figures can be collected so as to cover the entire output of the industry, so that they avoid the assumption that a selection of articles will show a " representative " movement ; in particular, they will automatically catch up any new products, and so avoid the kind of error discussed on page 29.

Secondly, the value figures will automatically make some allowance for shifts in the average quality of the articles produced, even where this would inevitably be lost in any series based on physical quantities. Admittedly, they may not make exactly the right allowance for this shift in quality, since it will be based on the increased selling value of the article, irrespective of whether this is due to the use of more material per article or more workmanship ; if the whole improvement were due to the former, it should be ignored, if entirely to the latter, then the increase in selling value will be proportionately too small. In the typical case, however, where some of each is involved, the rise in selling value may fairly reflect the rise in net output content, which is what is wanted. We may be reasonably certain that value figures will deal with quality shifts better than physical quantity series ; the latter are even liable to produce the wrong kind of result, since output is so frequently measured in weight as the only common denominator, so that the production of lighter (and better) machines, for example, would be recorded as a *fall* in output.

On the other side we may first consider the point that although the value of production provides a " sensible " means of combining the output of all the various products into a single figure, nevertheless it does not do so strictly in the way which we would have preferred. This matter was discussed on page 9, where it was shown that the proper way of adding up the output of the various products for index purposes is by valuing them on the basis of their net output content. In some cases this may be a serious reflection on the usefulness of the total value as an indicator, because the proportion of the selling price which is represented by materials may vary substantially as between one product and another ; the example of prefabricated and traditional houses in Chapter 3 illustrates

the point, and the same thing would arise if wool tops, yarn and cloth were added together on the basis of their selling value to measure the output of the wool textile industry. In general, however, the products of an industry tend to have broadly the same proportion of materials and net output content in their selling price, so that there is no risk of serious error. Moreover, we must not forget that even if this proportion varies significantly from product to product the indicator will still be reliable unless the composition of the industry's output changes significantly from one period to another.

There can be no doubt that the traditional preference for the use of indicators based on " hard " physical series springs mainly from lack of confidence in the price index numbers used for deflating value series so as to measure changes in the volume of output; with the present inadequate supply of proper information about the price movements of manufactured goods this suspicion is largely justified, and it can only be overcome if special efforts are made to collect information which would be suitable for these specific purposes. This is an objective which is worth pursuing for other reasons as well, and the method should not be allowed to go by default merely because it is difficult to produce a *perfect* price index for manufactured goods.

The type of price data which is required should aim at indicating price movements for a selected number of specific products, the quality of which would be kept as constant as possible. There is no need to cover the entire output of the industry, so long as a reasonable sample is obtained, and there is no need for the information to be collected every month. The essence of the problem is to get intelligent reports, made by people who appreciate the object of collecting the information and who can be relied on to deal sensibly with minor changes in the nature of the product. Since there is no question of recording the entire output of the industry under a limited number of headings, the specifications of the products for which prices are reported can be much more precise than any other statistical heading could ever hope to be.

It may, perhaps, be objected that there is no more reason for assuming that the price movement for the sample covered by the reports will be representative of price movements in the whole industry than in the case of outputs (see page 29). This is, however, almost certainly a false analogy. The forces acting on the price of one product of an industry are much more similar to those which act on the price of another of its products than is the case with the two outputs. Thus, it is almost certain that the type of labour employed will be broadly similar, so that movements in wage rates will be common to both, and the same will generally be true of materials, and often of changes in technique. There may, of course, be exceptions, but it is much easier to review an industry's products and divide them into sections within which we should expect price movements to be similar than it is to do the same thing with outputs ; once the products have been sectionalised in this way we can reasonably rely on a small number of quotations for each section giving a representative picture, and it should

also be possible to arrange that the quotations which are collected will represent a reasonably scientific sample.

It ought, perhaps, to be admitted that the arguments for expecting a similarity of price movement for different products of an industry are much weaker in disturbed times such as the post-war transition period. For this relatively short period, however, we can call in aid the argument that in the industries for which this type of indicator has been used (e.g., engineering and toys), the movement in the value (and quantity) of output was bound to be very large, so that firm information about that factor was more important than great accuracy in our estimate of the much smaller movement in prices. This argument is particularly useful since the information which was, in fact, available about price movements was lamentably weak, and certainly did not conform to the principles discussed above. In the main, we were forced to rely on movements in the average value per unit for various headings in the export accounts ; these headings do not relate to strictly homogeneous items (e.g., tons of electric cables) so that the apparent price change might be due to a change in the proportions of the various types covered by the heading, or in the average quality of some of these types. Furthermore, we cannot be sure that export prices will move in the same way as the prices for sales to the home market, so that a second act of faith was required.

There can, however, be little doubt that the only way to proceed for the industries in question was to start from the value of production, since this was the only reliable information available.

Input of Materials

The third type of indicator, which was used to cover some 15 per cent. of the weight of the index, is the quantity of some important material(s) consumed in the industry. This type has the advantage of being very convenient to use, since for many industries the number of principal materials is quite small (certainly far smaller than the number of different products) and the basic figures should be reasonably accurate on their own definitions.

We may usefully divide the discussion into two main sections : firstly, the problems which are inherent in the use of this type of indicator, even if we have reliable information on the actual quantities consumed by the industry, and are prepared to ignore time-lags ; and secondly, the problems which arise from time-lags and from the fact that our data may not strictly relate to the actual consumption of the industry.

The first group of problems really all spring from the implicit assumption that the volume of the industry's output will be proportional to its consumption of the raw materials for which we have data. There are three main factors which may upset this assumption :—

(*a*) The industry may also use other materials, not merely as a complement to the supposedly " basic " ones, but also as partial alternatives. If the proportions change, then clearly the indicators

will give a false result. This might be illustrated from our use of hemp consumption to reflect the output of the rope, twine and net trade, since other fibres are also employed, and the proportions are not strictly constant.

(*b*) Even if there is only one main material, it may be made into products which require a very varying amount of work per ton of material. One common reason for this may be illustrated from the jute industry, where the raw jute (which we use as an indicator) may go through both spinning and weaving processes and emerge as cloth or may be sold as yarn (e.g., for use in the carpet industry, or for export). If there is a rise in the proportion which only goes through the spinning process, then the consumption of raw jute will give too high an indication of the industry's output.

(*c*) Even if the proportions of the raw materials which emerge as yarn and cloth remain the same, there may be a shift in the average quality of one or other of these products, and naturally the consumption of raw jute will not reflect this quality change. (This difficulty is not, of course, peculiar to " input " indicators, since we saw that it also affected output when measured in physical terms, but with material consumption as an indicator there is no chance of reducing the error by getting the output subdivided by grades.)

Where statistics are used for more than one material it is sometimes possible to regard each of the materials as reflecting the output of a distinct section of the industry and give them a weight accordingly ; this applied, for example, to the case of wheat and maize in the grain milling trade. In other cases it may be appropriate simply to add the consumption figures together to make a single series, but the general principle should be to try to attach to a unit of each of the materials an importance corresponding with the net output associated with its use in the industry. This point may be illustrated from the case of the timber trade, which covers both sawmilling and the manufacture of a considerable number of relatively simple wooden articles (not including furniture). The best indicators which we could find for this trade were the production of British timber and the consumption of imported and British timber. We decided in effect to assume that the net output content of the work done by the timber trade on a thousand cubic feet of hardwood would average 50 per cent. more than the corresponding figure for softwood, and we divided the weight between hardwood and softwood accordingly. We also gave a double weight to British timber as against imported by adding together the production and the consumption of British timber, since imports often arrive in a sawn state and therefore entail less work for the industry in this country.

We may now turn to the second group of problems, which are concerned with time-lags and imperfections in the data. Clearly, even if we have accurate statistics of the quantity of materials consumed by

an industry in each month, this is strictly speaking a measure of input rather than of output. If we were trying to produce an index which would measure the movements in the "work done" by the industry from month to month, then we could say that there was as much justification for using input as output to reflect this. The upshot of the discussion in Chapter 3 was, however, that the basic concept of the index must be the quantity of goods *completed* in the period, rather than the amount of work done, since the bulk of the data in fact related to completions. It is, therefore, a defect in the index that this section should be based on input statistics, and we considered the question of introducing a time-lag. For most of the industries concerned, however, the time-lag would only have been a small one, and it appeared that in fact its introduction would do more harm than good. This apparently paradoxical result may be seen by considering the statistics for a holiday month (e.g., December). The input series naturally show a drop for that month, and we may be quite certain that output also drops. If we introduced a time-lag of one month, on the argument that the material normally took one month to pass through the productive process, this dip in output would be transferred from December to January ; the seasonal pattern would then clearly be wrong, whilst any trend would be barely affected. We decided, therefore, to use the figures as they stood on the assumption that input and output were, in fact, very closely correlated and that the correlation could not be improved by any simple device for a time-lag.

A more serious objection arises in cases where the available data do not actually relate to the quantity of materials *consumed* by the industry in the period, but rather to the quantity *delivered* to it. This means that no allowance will be made for changes in the industry's stock of materials, and these changes may easily be significant compared with the consumption of a single month. Here again, however, the error involved is not one which can accumulate indefinitely, even though it is likely to produce a temporary upward bias in the index at some stage as stocks rise from the low level prevailing at the end of the war. It seems clear that nothing can be done to adjust the index for stock changes from month to month, and even a general adjustment spread over a longish period would be very uncertain with the present lack of reliable data.

Finally, there are some cases where the data do not even relate to the quantities of materials delivered to this particular industry, but only to the quantities becoming available for the British market as a whole. Naturally, this type of indicator should not be used unless the industry in question is, in fact, a predominant consumer of the material, or unless there is no other series which can be said to reflect movements in its output even very broadly. The implied assumption in using such an indicator is, of course, that the proportion of the total supply of material which goes to this industry will not change sufficiently to affect the result very seriously. A few examples may help to illustrate the reasonableness or otherwise of this kind of assumption :—

Firstly, the total supply of certain plastic materials becoming available

for home use was adopted as an indicator for the consuming section of the plastic materials, buttons and fancy articles trade, on the grounds that this was the main user of such materials.

Secondly, the quantity of printing and writing paper (other than newsprint) becoming available for home use was adopted as an indicator for the general printing and manufactured stationery trades combined, since again these were the main consumers.

Thirdly, a series for total disposals of maize was used as an indicator for the maize section of the grain milling trade ; the proportion of the maize supply which is milled may vary very substantially, but, as explained on page 25, it seemed clear that this indicator would give a better result than anything else which was available.

The treatment of the textile finishing trade was really based on this principle. Its weight was split between the series for production of various textiles in proportions based on the 1935 census of production. In effect, this amounts to assuming that the total output of (say) cotton or rayon cloth will move similarly to the input of such cloth into the finishing trade ; the information available does not permit us to allow for any change in the proportions of cloth which have more (or less) elaborate finishes applied to them, or which do not pass through a finishing process at all.

Employment

The only other general category of indicator used in our index is based on the numbers employed in the industry ; this covered about 12 per cent. of the total weight. It is, of course, an indicator of the volume of work done rather than of completions.

An indicator of this kind needs to have routine adjustments for holidays (see page 20), and care must also be taken to allow for any major catastrophe which may affect output but not employment, such as the fuel crisis. Both these corrections have been incorporated in all our employment series, and although the adjustments are rough, there is no reason to suppose that the error is on balance serious ; in the nature of the case it certainly cannot be cumulative.

Strictly speaking, adjustments ought also to be made, if only roughly, for changes in the average number of hours worked per week and for changes in output per man-hour.* The Ministry of Labour publish comprehensive six-monthly information on the former factor for each industry, but on the latter one can only resort to indirect methods. Thus, one might assume that movements are similar to those in other industries for which output statistics exist, or one might take the movement shown for the industry in question between past censuses of production ; in exceptional cases trade advice based on general impressions or costings might help.

* The Federal Reserve Index is, in fact, largely based on adjusted series of man-hours worked. See Bibliography [3, 4, 5.]

Although it is important not to allow an index to run for very long without adjusting for these two factors, we have not yet thought it worth while to undertake the work involved. The employment series only cover 12 per cent. of the index, so that the percentage adjustment would have to be substantial to make any great difference to the index as a whole, or indeed to any of the groups. A rough study of the data on hours and productivity did not suggest that either factor would be of much significance for 1946-48 and to some extent they would cancel one another out.

If corrections are made on the above lines, or if consideration suggests them to be of little importance in the particular case, then we see no good reason for the common prejudice against using employment series to fill up some of the awkward gaps in the information. It is, of course, a question of weighing alternatives, and clearly it would be unsatisfactory to use employment for too large a part of the index, even if the series were fully adjusted in the way described above. But where the information about an industry's output and input is not very reliable, or would require a disproportionate amount of computing work because a small industry has a very heterogeneous output, then the use of employment is fully justified. It gives a series which has the merit of being based on up-to-date reliable returns and covering the entire activity of the industry, and it enables a substantial sector to be covered with very little computing work. Naturally, it is less satisfactory if the index is to be used for making comparisons over a period of ten or twenty years, because an inaccurate allowance for changes in productivity might produce a big cumulative error ; but the function of a monthly index is to give a quick measure of short-term movements in output, and long-term comparisons should be based on the fuller information which is often available on an annual basis (see Chapter 9).

The main reason for the prejudice against the use of employment data is probably that one use for an index of production is to provide a comparison between its movements and those in the numbers employed, so as to assess changes in productivity ; the argument then is that inclusion of the same employment data in both series means that the answer will simply depend on the adjustments (if any) made for changes in productivity, so that one goes round in a circle.

A great deal might be said about this contention. In the first place, we are frankly sceptical as to whether a monthly index of production can ever be sufficiently accurate to justify any but the broadest and most tentative conclusions about changes in productivity, even if the employment data were beyond question. These changes are unlikely to be more than about 3 per cent. *per annum* for industry as a whole, so that the comparisons must normally be made over relatively long periods to have any hope of being at all reliable. It is natural then to make use of the full range of annual data (thus incidentally avoiding seasonal problems), instead of confining oneself to the limited selection which is available monthly and used in the index.

Even if we accept, however, the proposition that the monthly index

ought to be suitable for productivity comparisons, the argument against using employment data to fill awkward gaps still does not hold good.

The logical course would, of course, be to confine the index to that part of industry for which reliable data on output are available, and to compare it with corresponding employment figures ; the result should only be described as applying to the part of the field covered by the index, and we would have to confess our ignorance about movements over the remainder of industry, or in industry as a whole. This is the purist's line, but we saw in Chapter 2 that there are very serious objections to confining the scope of the index to an arbitrary part of industry defined on the basis of what information happens to be available.*

If the scope of the index is not to be restricted in this way, then the use of employment series to fill the awkward gaps seems actually to be one of the *best* procedures for productivity comparisons. If they are not adjusted for changes in productivity, then the result is to damp down the movement which would have been found for the other industries, but not to alter its direction ; moreover, the damping cannot be great when only 12 per cent. of the index is affected—if the other industries show a rise in productivity of 2.5 per cent. this will be reduced to 2.2 per cent. If the employment series were given an assumed change in productivity exactly equal to that recorded for the others the computed answer would, of course, depend simply on those industries for which reasonable information exists ; this is unlikely to happen exactly in practice, since in computing the monthly index number the correction for productivity has to be assumed in advance, but the answer will be affected very little by any difference in this small factor.

By way of contrast, let us see what happens if some series other than employment are used for the awkward industries. We might resort to some very indifferent output indicators—say, the quantities of a single product in each industry for which statistics happen to be available, but which cannot really be said to be specially "typical." This avoids making any explicit assumption about changes in productivity for those industries, but it involves a series of acts of faith about the other products, each of which involves a risk of error to which we can set no reasonable limit ; admittedly, many of these errors are probably independent, and so may partially cancel out, but we really have no knowledge as to the distortion which they may introduce into the answer.†

* The proper deduction seems to be that the index should attempt to measure movements in output for the whole field, but that productivity comparisons (which require a far higher standard of accuracy than many other uses of the index) should be confined to a much narrower field for which the data are considered good enough. This would entail the elimination of many series besides those based on employment ; the fact that it can only be done with the collaboration of the compilers of the index seems to us an advantage, since familiarity with the data is needed to decide which series can reach the exacting standard required for anything but the broadest of conclusions.

† The only way of finding out (tell it not in Gath !) is to compare the dubious output series with the employment figures for the same industries, and so find out what assumptions about productivity changes were indirectly involved in our acts of faith. The results are sometimes startling.

Alternatively, we might follow the classic procedure of assuming the output of the awkward industries to move with that of the group in which they happen to be classified. We have already expressed our distrust of this assumption (see page 6), and for productivity purposes its automatic use may lead to ludicrous implied assumptions. Thus, the employment of the industry may have doubled over the period, because it was concentrated during the war, whilst the output of the group has remained stationary, so that the implied assumption is a fall in productivity of 50 per cent. Whether we want the index for productivity comparisons or for some other purpose, it is more reasonable to make use of the employment data and assume that an awkward industry moves with its group in respect of *productivity* changes (which are seldom rapid), rather than to ignore the employment data and assume similarity of movement for its *output* (where changes can be very swift).

CHAPTER 6

TIME PERIODS AND SEASONAL MOVEMENTS

The discussion so far has not dealt with a group of problems which arise mainly out of the vagaries of the calendar and the seasons. We have spoken about a " monthly " index, and sought for indicators which would show how the volume of production in each industry moved " from month to month." But " months " are varying things, and no attempt has been made to define precisely what it is that we want to study, nor yet the means by which our indicators can be made to throw light on that particular concept. In effect we have now to continue the process begun in Chapters 2 and 3 of giving precision to the broad idea of a " monthly " index, by reconciling the logical ideal with the practical limitations set by the data. We shall find that there are at least two quite different concepts for which it would be very useful to have a measure.

The subject divides fairly readily into two main parts: the discussion of logical objectives and the detailed methods by which the various kinds of data can be manipulated to comply with our requirements.

The Logical Objectives

The simplest way of deciding what one would like the indicators (and so the index) to reflect is by asking oneself a series of questions. We may assume that the objective is to set down one figure against each of the twelve months in the year, however much one might be attracted by the more logical idea of thirteen four-weekly periods adopted for food rationing and in certain Controls' statistics. And we must remember that the only function of an index is to *compare* production in one period with production in another: it gives no absolute figures at all.

The first question is, then, does one want the figures to reflect strictly that amount of production which took place within the calendar month ? This question may perhaps be put rather more informatively by asking whether one wants the index for February normally to be about 10 per cent. lower than those for January and March, because it is a shorter month. Our answer is an emphatic negative: this sort of movement is of no interest, and it would be infuriating if one's first action in using an index had to be to eliminate the effects of the varying lengths of month. Production is a flow, and we want to compare the rate of flow in each month.

Does one, then, want to measure the *daily rate* of production for the days falling within the month ? In industries which work continuously through the week-end, such as pig iron production, this would be quite appropriate. But for most industries it would mean that the index for

months which happened to contain five Sundays (e.g., October 1948) would be artificially depressed relatively to those which contained only 4 (e.g., November 1948); moreover the position would be made worse if, as on that occasion, the first month also contained 5 Saturdays and second only 4. If Saturday is really only equivalent to half a normal day for production purposes then the vagaries of the calendar would produce a spurious rise between October and November of over 5 per cent. in the index if this factor were ignored and a plain daily rate used; such an index would be almost worse than the " calendar month " one, since the adjustments would not always be needed, and so might be overlooked by the user.

The fact is that the fundamental time period for production is the week, and not the month: what we want our indicators to reflect is changes in the weekly rate of production, and the simplest way of doing this is to set against each month the rate for those weeks (either 4 or 5) which mainly fall within it.

The week-end is not, however, the only time at which production is interrupted: there are general (" bank ") holidays at Christmas, etc., and most industries have some sort of scheme for holidays with pay. Does one then want the index to show a fall on this account in August, December, and whatever months happen to contain Easter and Whitsun? The answer to this question is not, in logic, quite so clear-cut, because it is a case where information on both bases would be useful. The case for saying that we want to have an index which will show the fall is simple: there *was* a fall in output, and the effect on the supply of coal, or of goods becoming available in the shops, is just as real when the cause is a holiday as it is when the labour force falls or productivity declines for some reason. Moreover it would be particularly deceptive if an additional holiday (e.g., Victory Day in 1946) were not allowed to affect the index because the figures were automatically adjusted for the smaller number of days worked.

The main case for a second index which would eliminate these holiday fluctuations is that for various purposes one may be concerned with the trend of production rather than the level for a particular month. In these cases it is irrelevant to be told that production fell in August, or December, if the reason was simply the holidays; such a passing factor is of no account, and one would like to know what the figure would have been " if the holiday factor had been eliminated."

As a broad idea this desire to eliminate the holiday factor is attractive, but it is a rather elusive one when it comes to precise definition, quite apart from any practical difficulties over getting the data. We can perhaps visualise an indicator which is raised in accordance with the percentage of man-hours actually lost through people being on holiday in each month, but we ought to deduct an allowance for any overtime worked by the remainder of the staff, because of their absence, for any consequential new recruitment, and possibly for greater effort generally. And it seems logically almost impossible to separate out how much of

the overtime, the recruitment, and the increased effort are to be attributed to the holiday, and how much to other causes such as a change in demand (which may itself reflect the holidays in other industries).

We should not dismiss the idea of an index " adjusted for holidays " as useless merely because it is difficult to make it logically quite precise. The student of trends would prefer an index which eliminated the major disturbances to a completely unadjusted one even if these had to be defined rather arbitrarily as including only the " bank " holidays, and perhaps one or two extra days in August. He would probably like the adjustment made in the basic series, and varied from industry to industry in the light of any special conditions (e.g., the Lancashire wakes, or the continued production of electricity even at holiday times).

Adjustment for Seasonal Fluctuations

This leads us to the wider question of seasonal variations of other kinds. Holidays are a special instance of a reason why output is regularly depressed in certain months (two of which, however, themselves vary according to the vagaries of Easter and Whitsun). There are many other factors which cause seasonal variations, some of which are mainly attributable to Nature—e.g., the summer fall in gas production and the winter activity of sugar beet factories—but others of which are more within man's control—e.g., the pre-war fluctuations in tailoring to meet traditional seasonal demands. Does one want the index to reflect these fluctuations or should the series be adjusted in some way to eliminate them?

It seems clear once again that an unadjusted series is certainly needed to reflect what actually happened. Whatever the reason, the output of gas did fall in the summer, the output of suits did rise before Whitsun; incomes of producers were affected accordingly and so was the supply of goods becoming available. We may want to have an adjusted series as well, but our first call is for the plain facts.

The logical difficulty about adjusting for seasonal factors of a general kind is that there is no clear concept of what one is then measuring. In the case of holidays it was possible to define the adjusted series, at least approximately, as reflecting changes in the rate of output *per working day*; indeed, we need not logically regard this as an " adjusted " version of the other series, since the concept has a logical meaning of its own, and the information could be assembled on that basis from the start. With a series adjusted for general seasonal factors, however, there is no way even of *defining* the concept except by reference to " the experience of past years." We can, no doubt, list some of the factors which will tend to cause seasonal fluctuations fairly regularly; but our list will probably be incomplete and we have no independent way of assessing their strength so as to say *how much*, for example, we are to adjust the output of gas in the summer months to allow for the effects of the warmer weather. Our series does not, for example, represent the output of gas

"per day of standard temperature," with the adjustment for each year based on the actual temperature recorded in that year; if we had no past records it would be logically impossible to produce a seasonally adjusted series for the first year, even if we could collect every scrap of information about it which we wanted.

This is very far from being mere pedantic word-chopping. If our seasonal series can neither be defined nor yet measured except by observing the net outcome of the seasonal forces in past years, then both its logical existence and its usefulness depend on the continuance of those forces at their old strength. If the institutional set-up and social customs change, so that fewer men regard Whitsun as the time to buy a new suit; or if technique changes, so that gas is stored in summer for use in winter; or if the reserve of labour or generating plant disappears, so that seasonal peaks simply cannot rise so high above the general level as in the past; if any of these or a host of other possible changes take place they may completely destroy the relevance of past experience and so the basis for a seasonally adjusted series. If there are no regular seasonal forces which will at least broadly have the same influence each year, then we are chasing a chimera.

The matter is, then, one of practical judgment, to be applied to the circumstances of each particular case. We must abandon the idea of a seasonally adjusted series as something with a logical existence of its own, because there is no logical way of defining the adjustment; we must expect to get a different answer according to the reference period we select, not merely for " chance " reasons analogous to sampling variations, but also because of changing conditions. But we often do decide that the seasonal forces operating in the period studied are likely to be sufficiently similar to those in some specified reference period to make it useful to calculate a secondary " adjusted " series, with the adjustment based on experience in that period. The starting point for the calculations would probably be the series showing movements in output per working day, if only because this partially overcomes the awkward effects of a shifting Easter.

Adjustments are in fact made on this sort of principle to the series used in compiling the U.S. Federal Reserve Index. The adjusted index numbers were a very valuable supplement to the unadjusted ones in most pre-war periods, but in the war the results were more misleading than helpful, because the seasonal forces had changed so greatly. This provides a striking reminder of the fact that a seasonally adjusted index is only useful if there is sufficient stability in the seasonal pattern; the reference period used for making the adjustment should always be clearly stated, so that users can form their own judgment about its relevance.

So far as our own index is concerned there is little doubt that seasonal corrections would be a waste of time. Neither pre-war nor wartime conditions were sufficiently similar to those prevailing now to make the resulting movements of much relevance, even if we had the necessary information about them. The period since the war is not only too short,

but also contained too many unstable factors (notably the fuel crisis) to serve as a basis for calculating a seasonal adjustment. For the time being, therefore, only the unadjusted index numbers, based on production per week, are calculated; the only supplement which might be useful would be an (unadjusted) index of production per working day. A first crude approximation to such an index is given in the final section of this chapter.

The Practical Problems

Having settled our objective, we have now to examine the methods by which the basic data can be adjusted to give information on the desired basis.

Statisticians as a class are bound to suffer from the vagaries of a shifting Easter and a calendar with uneven months containing fractions of a week; compilers of an index of production suffer a further blow from the varied systems adopted by their brother statisticians in collecting information. The following is a selection of the diverse periods to which the basic series used in our index relate:

(*a*) Weekly averages, with the figure for each month relating to those weeks mainly falling in the month.

(*b*) Weekly averages with the weeks arranged in some slightly different way (e.g., with the figures for the *last* month of the quarter always based on five weeks).

(*c*) Four-week totals, with five-week totals once (or occasionally twice) a quarter.

(*d*) Four-week totals running consecutively through the year, which give 13 figures for 12 months, so that the periods gradually diverge from the calendar months and then start fitting again if one is omitted.

(*e*) Calendar months.

(*f*) Pairs of calendar months.

(*g*) Calendar quarters, or quarters beginning with February or March.

(*h*) Numbers on the pay-roll at a particular date.

We have to transform each series so that we get a set of twelve figures for the year which will reflect the movements in the weekly rate of production between the different months; we are, however, only concerned with *ratios*, so that it does not matter if the figures in one series consist of (say) four-weekly rates, whilst in a second they are weekly.

No adjustment at all is needed to type (*a*), which in fact represents the easiest way of visualising what the index measures. Fortunately this type is a common one, particularly for the more important series.

Type (*b*) is not *exactly* what we want, since the figures for some "months" are calculated from periods which include a week that ought to go into another month. But nothing can be done to improve them and they are therefore used as they stand.

Type (*c*) merely requires that the five-weekly figures be reduced by one-fifth to make them comparable with the four-weekly.

Type (*d*), though thoroughly logical for its own purpose, causes great difficulties by failing to conform to the conventional illogicalities of the world as it is. It is not a common type, however, and we cut the knot by taking eleven of the thirteen periods as applicable to the months in which they mainly fell (say, January–May and July–December) and averaging the other two to represent June.

Type (*e*), being based on calendar months instead of weeks, presents the problem of making an adjustment for their differing lengths and the differing number of week-ends that they contain, so as to compute weekly rates. In industries in this group (e.g., rayon production) where the process of production is continuous, we simply divided the monthly output by the number of days in the month. For all other industries we divided by the number of " normal working days " in the month, counting Saturday as one-half and ignoring Sundays; some firms do not, of course, work on Saturday, but others have more than the equivalent of half-a-day, and this simple rule seemed to be accurate enough to give figures which could be regarded as moving in the same way as weekly rates would. It is important to remember that, for the reasons discussed above, no allowance is made for holidays, which are counted as normal working days in accordance with the above rule. We may, perhaps, note that, even without any disturbance through holidays, the number of " normal working days " in a month may be anything from 22 to 25, moving in units of $\frac{1}{2}$.

It would be possible to apply a similar technique to series of types (*f*) and (*g*), so as to get figures for each period which would move in the same way as weekly rates. It would not, however, be right to adopt the same rate as applicable to each of the months in the period if one of them had a holiday in it, or if there were some major disturbance like a fuel crisis. In effect therefore the recorded output for a quarter must first be allocated to the individual months and then the monthly technique applied.

If a substantial part of the index were covered by indicators of these types it might be necessary to adopt an elaborate technique for doing this spreading, including an allowance for trends. In our case, however, only about 10 per cent. of the total weight is affected, and even if there were a general upward trend, the fact that such diverse periods are used makes a correction for trend of little importance. Thus each month would have some figures raised by the correction (because it was the last month of the period for that series) and others lowered. Admittedly some months, notably January, tend to be at the start of a period for most series, but even in that case there are some off-sets, and the trend is not often very steep.

We decided, therefore, that the only regular adjustments to be made would be for holidays, since these are needed to prevent a *systematic* error for the months affected and can be made fairly easily. In addition,

we made special adjustments to periods covering the fuel crisis in February–March, 1947, and in certain cases where the initial figures for 1946 covered a large number of months.

The " holiday " adjustment was based on the principle that the output in the period would be divided between the months in proportion to the number of *actual* working days in each—i.e., the number of normal working days, computed as before, less those lost through holidays. The full formula for arriving at the figure to be used in the index for any month of a quarter is therefore

$$\text{Production in quarter} \times \frac{\text{No. of actual working days in month}}{\text{No. of actual working days in quarter}} \div \text{No. of normal working days in month.}$$

There remains the question of defining a holiday. We have chosen the rather austere line of counting only English bank holidays, together with those days that by custom go with them; August holidays being taken as three days in all. Thus the Whitsun holiday is 1½ days (Saturday morning and Monday); when Christmas is on Thursday, it accounts for 2½ days (Thursday, Friday and Saturday morning), but when it is on Wednesday it is taken as only 2 days (Wednesday and Thursday). Other variations are made in accordance with people's assumed habits, as the following table shows:

	Holidays	*Days*
1946—April	Easter	2
June	Whitsun and V-day	2
August	Holiday	3
December	Christmas	2
1947—April	Easter	2½
May	Whitsun	1½
August	Holiday	3
December	Christmas	2½
1948—March	Easter	2½
May	Whitsun	1½
August	Holiday	3
December	Christmas	2

The August holiday may appear rather short, but it represents a fall of about $\frac{1}{8}$ in that month's production. Moreover, in the " spreading " of quarterly figures, an equal number of holidays in July, August and September would not affect the proportions attributed to each month; all we have to allow for is the excess tendency to have holidays in August, and the assumption we have made would be consistent with a longer holiday per person, but with a moderate proportion of them taken in other months.

Finally, the adjustments to employment series (type (*h*)) are a little different. Apart from an occasional correction for changes in productivity or the average numbers of hours worked (see Chapter 5) and for catastrophes such as the fuel crisis, it is necessary to " import " into the figures an adjustment for holidays; and this consists merely of reducing the figure recorded for holiday months by the proportion of normal working days which were assumed to be lost.

Prima facie it might appear that the table of holidays used for adjusting employment series ought to give more weight to time lost through ordinary summer holidays than the one set out above, since we now have to compare August, for example, with the average for the year, and not merely with neighbouring months. Our study of the movement of weekly and monthly production series does not, however, suggest that the deduction ought to be any larger, and this is the crucial test. There are plenty of possible explanations: people may work harder just before or after a holiday, or to make up for the fact that *other* people are away on holiday, or there may be less time lost in the summer through other causes (e.g., sickness). Whatever the reason, we want to make the employment series serve as a substitute for an output one, and even if we knew that holidays by themselves caused a larger dip in the actual number at work we should not necessarily use this figure as a measure of output.

We have not thought it worth while to take account of regional variations in holiday habits; the most important of these do not affect the series to which we have to make holiday adjustments. Exceptionally, however, we have assumed that one industry, mainly concentrated in Scotland, will celebrate New Year.

A Crude Index of Production per Working Day

To illustrate the difference between an index of the weekly rate of production and an index of production per working day we have crudely adjusted our index (which is on the former basis) so as to give figures which are roughly on the latter one.

To compute a proper index of production per working day the original figures for each series should be adjusted separately, use being made of the factor which is most appropriate for that particular type of activity, and the index recomputed. As our table is only for purposes of illustration we have simply applied a crude adjustment to the index-numbers in our A series for August, December and whichever months contained Easter and Whitsun.

We first tried the simple method of using the adjustment for holidays applied to the employment series " in reverse "—i.e., multiplying the index by the number of " normal " working days in the month and dividing by the number of " actual," as computed above. It was clear, however, that this made too little allowance for the fact that a number of industries carry on working through the holidays (e.g., gas and

electricity) or work over-time before or after them. We therefore reduced the calculated adjustments by one-quarter, so that the table would give a better illustration of what a properly computed index would look like.

TABLE 1

ILLUSTRATIVE TABLE OF INDEX-NUMBERS OF PRODUCTION

(*a*) per week (*b*) per working day

Month	1946		1947		1948	
	(*a*)	(*b*)	(*a*)	(*b*)	(*a*)	(*b*)
January	89	89	107	107	117	117
February	95	95	85	85	123	123
March	96	96	102	102	115	**124**
April	93	**99**	104	**113**	124	124
May	102	102	108	**114**	117	**123**
June	97	**104**	115	115	123	123
July	97	97	105	105	113	113
August	93	**103**	101	**112**		
September	107	107	114	114		
October	112	112	121	121		
November	113	113	122	122		
December	107	**114**	114	**124**		

The adjusted figures are printed in bold type, and it will be seen that they make the series of production per working day a good deal smoother and so better for seeing the trend of output. July shows a marked dip in all three years, much of which would probably disappear if the series could be computed accurately so as to allow for July holidays (including Lancashire wakes) ; there is also a case for raising September, and we may well have cut down the adjustment for August unduly.

The other month which consistently shows low figures is January. This can hardly be attributed to holidays (*pace* the Scots), and shows that some irregularities remain, due to other causes. Presumably nobody would want to remove the influence of the fuel crisis, even though a literal interpretation of working days might be held to call for this result when the individual series are considered separately.

CHAPTER 7

WEIGHTING

This chapter deals with the problem of combining the series which have been chosen to represent the movements of individual industries, or parts of industries, so as to produce an index-number for industry as a whole, together with a manageable number of subsidiary ones for its major sectors. The subject falls into two main parts: matters of principle, and the calculation of the actual weights used in our index-number.

The Weighting Formulæ

There are two possible lines of approach to the problem of combining the series. As we shall see in a moment, they are really two ways of arriving at exactly the same result, but it is sometimes useful to think of the index in one way, and sometimes in the other. One might perhaps add that many of the mistaken ideas about index-numbers are fundamentally due to a confusion of the two approaches.

The best way of displaying the fundamental ideas involved is to consider a simplified case, in which we have information about output in physical terms for all the goods which are in fact produced, and use all these data in compiling our index.

The first method is the one described in Chapter 3. For each period we take the actual figures for the output of each product—so many tons of coal, square yards of wool cloth, bicycles, etc.—and multiply these by the net output content of one unit at base year prices—£x per ton of coal, £y per square yard of wool cloth, etc. The resulting "values" are then added up to give a total for the period, and the index is found by expressing this as a percentage of the total for the base period.

The second approach is to start by expressing the output of each product for the period as a proportion of its output in the base period. Each of these so-called "output relatives" would give the index for that particular product, and the problem is how to average them so as to get a single index for output as a whole. We do not want to attach equal importance to a 10 per cent. movement in the output of each product, and in taking our average we must apply "weights" to the relative for each product depending on how large a part of the total output this product represented in the base year; these weights must, in fact, be proportional to the net output of its producers. This method is known as taking a weighted average of relatives.

These two approaches can conveniently be set out in a sort of

mathematical shorthand. We first consider a particular product and write

q_0 for the quantity produced in the base period

$q_1, q_2 \ldots$ for quantities produced in succeeding periods

p_0 for the net output content of one unit in the base period.

On our first method of approach the " value " of the output of this product in period 1 would be $p_0 \times q_1$, and the total " value " for period 1 for all products would be written $\Sigma p_0 q_1$ (the symbol Σ being short for " the sum of terms like this one for all commodities ")

The index for period 1 would then be

$$\frac{\Sigma p_0 q_1}{\Sigma p_0 q_0} \times 100.$$

On the second approach we write

w_0 for the weight to be attached to the product (=the net output in the base period)

$r_1, r_2 \ldots$ for the " output relatives " in periods 1, 2, etc. (=the proportions which the output bears to that in the base period)

Then the formula for the index in period 1 is

$$\frac{\Sigma w_0 r_1}{\Sigma w_0} \times 100$$

Now it is easy to see that these two formulæ are in fact identical, so that the two methods must inevitably give the same result. For w_0, the net output in the base period, is simply equal to the product of q_0 (the number of units produced) and p_0 (the net output contained in each unit); and r_1 is simply q_1 divided by q_0. If we substitute these values in the second formula the bottom line is clearly the same as in the first ($\Sigma p_0 q_0$), and the top one is

$$\Sigma\left(p_0 q_0 \times \frac{q_1}{q_0}\right)$$

The two q_0's cancel out, and we come back to the first formula.

In ordinary language we can think of the second method as using an alternative way of arriving at the total " value " of the goods produced in period 1, measured at base-period " prices " (more strictly, net output contents per unit). Instead of starting with the outputs in tons, square yards, etc., as we did in the first method, and multiplying them by the base-period " price," we start from the base-year " value " for the output of each product (quantity × " price ") and adjust it for the proportionate change in the quantity in period 1.

In the presentation of results it is natural to stress the second method of approach. One can add up the weights attached to each individual

series so as to arrive at the weight for each of the groups for which subsidiary index-numbers are prepared; this shows how large a part of the whole the activity represented by that group was in the base period, and it also enables the user to calculate an index for any combination of these groups which he may require. The index-numbers are themselves relatives and the weights suitable for the second approach are naturally associated with them.

The second approach is also the more natural when we are dealing with more complicated cases than the simple one used above, especially when the output of one product is used to represent movements over a wider field. To take an example, we use the output of complete bicycles as our only indicator for the bicycle industry, although it also produces a considerable value of spare parts and accessories, which are sold separately. It is a fairly natural line of approach to say that we start from the total net output of the industry in the base period, and compute the figure for period 1 by assuming the volume of output to have moved in the way shown by the indicator. It is less natural to say that we multiply the number of bicycles produced in each period by a factor equal to the net output " associated " with each in the base period, since this factor is really nothing more than a statistical concept, found by dividing the net output of the industry in the base year by the number of bicycles produced.

Throughout the rest of this chapter we shall, therefore, be approaching the problem by the second method and the word " weight " will be reserved (as it has been throughout the book) for the base-period net output which is to be applied to a series of relatives. As the next chapter shows, it is frequently easier to deal with logical problems associated with index-numbers by thinking of the first formula; and a common source of confusion is the mixture of ideas suitable for one formula with those appropriate to the other.

The Principles for Computing Weights

The main principles of weighting spring naturally from the above discussion and that in earlier chapters. As between industries the weights should be proportional to their net outputs in the base year, after these have been adjusted to allow for the exclusion of certain activities from the scope of the index. Within an industry, if more than one indicator is used for it, the weight attached to each should be proportional to the net output content of those activities which are assumed to move with it.

These principles need a certain amount of elaboration. At the industry level, if we may for the moment assume that we know the net output for the base year, the main exclusions will consist of the proportion represented by repair work, the production of finished munitions, and any increase of work-in-progress. The last point has already been mentioned at the end of Chapter 3, but it is perhaps worth repeating that this exclusion would have to be made wherever we were using completions

as our indicator, even if we wanted our index to measure changes in "work done" rather than completions. The point was of major importance in 1946 in relation to the production of civil aircraft, since in that year a great deal of work was done on the early stages of producing new models (e.g., the giant Brabazon I). This raised the figure for net output, but did not affect the indicator which was at a low level; if it had been allowed to get into the weight it would have been tantamount to assuming that each aircraft produced was far more valuable than in fact it was. Moreover this error would have remained permanently in the index: the subsequent rise in the indicator would have caused aircraft production to be counted as far too large a proportion of total industrial activity.

There are two other problems at the industry level which ought to be mentioned. First, the definition of net output used in the census of production is not strictly appropriate for this purpose, since deductions ought to be made for depreciation and the purchase of services from people outside the industry*; these deductions would represent a varying proportion of the industries' net outputs, and so affect the relative weights, but in the absence of data we have not attempted to make the correction. Secondly, an "industry," say the biscuit industry, means the collection of factories, etc., which are classified as falling within it because their *major* activity consists in producing biscuits, and the net output of the biscuit industry reflects the total activities of those factories. Some of this activity will consist in producing as side-lines goods normally associated with other industries, and contrariwise some biscuits will be made by factories outside the biscuit industry. The output statistics which we use as an indicator, however, relate to the total output of biscuits and logically the weight to be attached to this indicator should be the net output involved in making biscuits, wherever they are made, rather than the total net output of those factories classified in the biscuit industry. As a rule, however, the overlaps between industries broadly cancel out, so that the industry figures are sufficiently accurate for weighting purposes.

The more serious problems arise at the second stage of dividing the weight for the whole industry between the various indicators. Sometimes there is an obvious answer because the industry can readily be divided into what are virtually separate sub-divisions, each with its own net output, and there is one indicator for each of these. But, as explained in Chapter 4, with some industries the plain fact is that the indicators only "cover," in any direct sense, a proportion of its output, and it is really an act of faith to assume that the remaining products are "represented" by them at all. This is a matter on which it is difficult to lay down any really useful rules. Logically the general principle should, of course, be to consider the "uncovered" products as carefully as possible, and decide which of the available indicators (including those

* See Bibliography [6], pp. 340-350.

used for other industries) is most likely to show similar movements in output to each one. This procedure should indeed always be tried first, but it is apt to be laborious, and if the connecting links are very weak or absent its results are mainly negative.

At the other extreme one might adopt a mechanical method by computing the net output strictly represented by each of the industry's indicators, and distributing the remainder *pro rata*. This has an attractive appearance of logic, since it leaves the movement in this industry's output the same as it would be if we ignored the part about which we have no information. The logic is however really specious: we are not concerned with the index for a single industry, and for the total index there is no particular logic in saying, for example, that a greater proportion of the miscellaneous rubber goods will be assumed to move with motor tyres than with rubber boots because the output of the former is greater. It would be just as logical (or illogical) to say that the weight appropriate to the missing part would be divided *equally* between the available series, or perhaps according to an assessment of their accuracy at measuring their own output. The fact that a particular series already carries a large weight might even be considered a reason for *not* giving it much of the uncovered section, if it were at all likely to behave in an untypical fashion.

In effect, there can be no fixed rules which will dispose of these problems. Perhaps the most important point of all is to remember what in fact one is doing—i.e., assuming that the output of products X, Y and Z will move with indicators A, B or C—and to seek diligently for a new indicator, which will have a more direct connexion with the output of one or more of these products, if the net output at stake is large and the link with A, B and C very tenuous. The processes of choosing indicators and assigning weights are intertwined, and we must stress that the important things are *the absolute amount* (not the proportion) of the industry's output which is uncovered, and the likely error involved in assuming it to move with the rest.

Computation of the 1946 Weights

As a normal rule one would choose as base year one for which there had been a census of production, which would give the net output for each industry, and also the particulars of individual products. On this occasion it was necessary, for reasons discussed in the next chapter, to adopt a base year for which only a partial census was taken, the results of which had not begun to be published when we started our index. This raised a number of formidable problems, but a similar situation is not likely to arise again, so that the account of our struggles to overcome them is mainly " for the record "; the essential facts are given for each industry in Part II, and this summary can be very brief. The saving grace was, of course, that weights do not have to be computed very accurately, and depend only on the ratios of the various net outputs.

Weighting

Our main task was to assess the net output for each industry as defined for the 1935 census of production. For a number of industries—e.g., electricity and coal—information collected by other agencies had been published for a recent year, from which it was possible to make a direct calculation of the net output in 1946 on a definition similar to that used by the census. For building the figures of gross output given in the National Income White Paper provided a basis from which net output could be estimated for the various sections.

In general, however, the procedure was to start from the net output in 1935, and to estimate the net output in 1946 by one of two methods.

The first was to take the percentage movement between 1935 and 1946 in the total annual wages bill for a closely corresponding industry, on the Ministry of Labour definition, as deduced from the earnings enquiries and the numbers employed; wages represent a large constituent of net output and one which tends to be a fairly stable proportion of the whole, so that this percentage movement gave a reasonable multiplier to apply to the net output in 1935.

The second method was to use an indicator of the percentage movement in the quantity produced and in the average price, so as to obtain the movement in the *gross* output of the industry between 1935 and 1946. This factor was then assumed to apply also to the net output, which is a plausible enough assumption unless there is some obvious reason to the contrary. In some cases there was such a reason, because the price of the materials had risen dramatically (e.g., oilseeds) and it was clear that the " manufacturing margin " had not risen so steeply as the price of the finished product. In these cases we attempted to assess the rise in this margin (e.g., the net amount received by the seed-crushing firm per ton of seeds crushed), and used that factor instead of the price rise for the finished product.

This second method could only be used in cases where the industry had a small number of products, for which information was available on the movements of both quantities and average prices. It was particularly useful in dealing with census trades which are grouped together in a single category by the Ministry of Labour, but which are known to have moved differently (e.g., the various sections of " drink industries " and " other food industries").

The two methods called for rather different techniques in dealing with the exclusion for repair work, munitions and increased work-in-progress. The second one presented the easier problem, since it was only necessary to exclude these elements from the net output for 1935; this was a relatively stable year, so that the work-in-progress factor was not significant, and anyhow the census provided the necessary information. If the 1935 figure was adjusted to correspond with the goods completed in that year, the 1946 one would automatically be on the same basis.

With the first method, however, there was no escape from the fact that the movement in the wages bill between 1935 and 1946 reflected the movement in the *total* net output of the industry, whatever the nature

of the work on which the wage-earners were engaged. It was necessary, therefore, to start from the 1935 census figure and compute first the total net output for 1946; the deduction for munitions, work-in-progress, etc., had then to be based on a rough assessment of the proportion which these represented in 1946. In most trades no deduction was necessary, but in engineering and allied industries an allowance was clearly essential. Some scraps of information were available, but the best that could be expected was to get the order of magnitude of the final weight right.

The problem of changes in work-in-progress was, of course, specially acute in the building industry, for which the basic information for 1946 was obtained from the National Income White Paper. The matter is discussed on page 109, but it is worth noting that the B index (based on work done) gives building a substantially higher weight than does the A. This reflects the fact that completions were disproportionately low in 1946. The A indicators have subsequently shown a much steeper rise, and in the first half of 1948 building effectively represented much the same proportion of both index-numbers; indeed, the proportion was slightly greater for the A index, because the number of houses completed was, if anything, rather high in relation to the work done at earlier stages.

Shipbuilding is the other industry for which we calculate a separate B index, which reflects movements in the volume of work done by giving equal weight to the tonnages of ships *begun, launched* and *completed* in the period. In this case the change in the number of ships under construction between the beginning and end of 1946 was too small to justify different weights for the A and B series.

There is little which need be said about the method by which we divided the net output of an industry between the different indicators, where more than one of these was used to represent it. We started by considering the information from the 1935 census; this nearly always gave the gross selling value of the products concerned, and sometimes the net output of the factories which were mainly engaged in making them. In either case we could often make a rough estimate of the corresponding 1946 figures from price and quantity movements in the way discussed above, and these provided a basis for splitting the total net output of the industry in 1946. If price movements were not available we sometimes assumed them to be similar for the various sections, and adjusted only for the change in quantity. In other cases, particularly where no suitable 1935 quantities were available, we obtained a rough estimate of the relative 1946 values by multiplying the quantities of each item produced in that year by an assumed average price (such as the average value per unit exported).

The real difficulties arose, of course, where the indicators did not really cover anything like the whole output of the industry. Since the apportionment is then largely an act of faith there was no great merit in elaborate calculations, and we worked from the 1935 figures in making the rather arbitrary decisions, unless there was some clear reason to the contrary.

The Problem of Small Firms

Finally a brief reference should be made to the problem of the small firms which were not covered by the 1935 census of production. Logically an estimate of their net output ought to have been made and added in whenever we were using the 1935 census to compute the weight for an industry. We decided, however, that any gain in precision secured in this way was not worth the extra work involved, especially as the industry most affected (building) was treated by a different method which covered the small firms. This may well have been an unduly cowardly or lazy decision (see page 81), but there are a number of points to be considered.

First, it is of course only the *ratios* of the net outputs which matter, so that the exclusion will make no difference to the final answer where an industry has an " average " proportion of small firms.

Secondly, although the small firms tend to cluster in a relatively small number of industries, their inclusion would not raise the weight of those industries by as much as one might expect, because they frequently do a lot of repair work. By deciding to omit repair work from the scope of the index we completely eliminated two trades with a large number of small firms—motor repair garages and boot and shoe repairers; for other trades the inclusion of small firms would increase *total* net output but would also raise the deduction to be made for repairs.

Thirdly, if the trades with a lot of small firms are considered one by one there is nearly always something to be said for reducing the weight which a strict calculation based on the census would give to them. Fundamentally the most common reason is that the smaller firms in these trades largely sell their output direct to the public, and the census definition of net output will then include a certain amount of value which might more logically be attributed to distribution rather than production; the baking trade is a good example, but the point also applies very widely—e.g., to bespoke tailoring and perhaps jobbing printing. A large number of excluded " under-tens " nearly always implies a large number of slightly larger firms which are covered by the census, so that a fair proportion of the recorded output will be over-valued in this sense.

Another reason is that some of the work done by these trades is on the border-line of what might be called services, as opposed to production. The work of alteration done in dressmakers' workrooms, which is covered by the census, is an example.

These considerations do not, of course, provide any scientific reason for reducing the weight of the industries with a lot of small firms by precisely the amount represented by the activities of these firms. But they do give some grounds for saying that the work of making a special allowance for them when doing the calculations would not increase the accuracy and usefulness of the final index by very much.

CHAPTER 8

THE CHOICE OF BASE YEAR

Discussion with a number of people since the appearance of our index has shown that there is a widespread misunderstanding of the effects exerted by the choice of base year, which are often much exaggerated. Other experience shows that this misunderstanding is not in any way peculiar to our index, but relates to index-numbers in general; it is, however, of particular importance in this case, because our base year, 1946, was clearly in no sense "normal." The obvious distortion of the industrial structure in the base year was sometimes considered to invalidate the index "because the weights must soon become all wrong, as in 1946 some industries had not recovered from their wartime contraction, and others were still inflated."

The object of this chapter is to consider the main consequences of selecting one base year rather than another. Our choice of 1946 was in point of fact rendered almost inevitable by the nature of the data, since many of the series which we used as indicators cannot be carried back to any pre-war year, and 1947 results were not then complete. There is no need, however, to take refuge behind this defence of expediency; a dispassionate analysis shows that 1946 is on the whole preferable to any pre-war year, even if 1947 might perhaps claim some advantages over it.

The Effect on the Formulæ

The influence of the base year can most easily be seen by reverting to the simplified example mentioned in the last chapter, in which we have information about output in physical terms for all the goods which are produced, and combine all these data to make our index.

We saw there that the formula for the index in period 1 was

$$\frac{\Sigma p_0 q_1}{\Sigma p_0 q_0} \times 100.$$

In a similar way the index for period 2 would be

$$\frac{\Sigma p_0 q_2}{\Sigma p_0 q_0} \times 100.$$

The bottom line is always the same, being the total net output of the base period.

Now if we wanted to compare output in period 2 and period 1, we

would simply divide the second index-number by the first, and our answer would be

$$\frac{\Sigma p_0 q_2}{\Sigma p_0 q_1}$$

It will be seen that this answer does not depend at all on the *outputs* of the various products in the base year, but only on their " prices " (more strictly, their average net output contents per unit). If we had chosen some other year as base, say, year 6, the ratio of the two index-numbers would be

$$\frac{\Sigma p_6 q_2}{\Sigma p_6 q_1}$$

Now we would admittedly expect this ratio to be slightly different, but this difference (which might be in either direction) depends on the " *prices* " of the various products having moved differently between the two possible base years. The level of the *outputs* in the base year is irrelevant—or rather, it can only affect the issue indirectly through its effect on the " prices."

This result is perfectly in accordance with common sense: to compare the volume of production in a series of periods the most natural method is to adopt a common list of " prices " and use them to value the quantities produced in each of the periods. The important thing then is to choose a sensible set of " prices ": the fact that we put one year rather than another as 100 when we turn the results into index-number form merely alters the general level of the series without affecting the movements (which is what matters).

What, then, is the fallacy in the argument that a distorted pattern of *outputs* in the base year will, of itself, upset the index by producing a distorted set of weights ? The answer may be seen by considering the second method of approach used in Chapter 7, which showed how these weights are, in fact, used to calculate the index. We may reasonably simplify the exposition by assuming that all prices are stable, since we are not for this purpose concerned with the effects of changing prices.

The crucial point is simply that the weight for each series is not multiplied by the actual figures of output (measured in tons, yards, etc.) but by the output relative—i.e., the ratio of output in the period considered to that in the base. This means that the base year output not only affects the weight, but also the thing by which it is multiplied and the two effects exactly off-set one another.

In symbols, the weight is p_0q_0 and the output relative is $\frac{q_1}{q_0}$; when we multiply them together the q_0's cancel. In ordinary language, if we had taken a pre-war year as base instead of 1946 we should have doubled the weight given to carpets because the output was then twice as high,

but the output of other periods would have been expressed as a proportion of that higher figure, so that the relatives would all have been halved. Carpets will represent just the same proportion of the total index in later periods, whichever we choose as base, unless relative prices change.

Two corollaries of this analysis may usefully be mentioned at this point. First, in deciding whether a product is sufficiently important to justify the work of including it as one of indicators we should not really confine our attention to its output in the base year, but should consider any likely growth over the period covered by the index. As a case in point, we take the question of maize-milling, mentioned in Chapter 4. The weight attached to this series was trifling, only 0·2, because the supply of maize in 1946 was so low. But the pre-war figures showed that the indicator might well rise tenfold or more over the base, and March, 1948, showed a sixfold rise. Consequently the effective weight in March, 1948, was 1·2, and the very fact that it had been so low in 1946 made it all the more necessary to include it, because the movement was far from typical.

Secondly, it is a common practice to take the figures for an index-number and re-write them with another year as 100 by plain division; the procedure is usually described, rather ambiguously, as " shifting the base." It is not, however, the same thing as selecting a new year as base for the calculations. If we think of the index according to the first formula, a shift of this kind from year 0 to year 6 means that the formula for the index in (say) year 8 is now

$$\frac{\Sigma p_0 q_8}{\Sigma p_0 q_6} \times 100.$$

We are still using the " prices " of year 0 in valuing the outputs of the different products, even though year 6 is now described as base. If the reason for shifting was that year 0 is rather a long time ago, this may be a serious matter—not only because the price pattern in the ordinary sense may have changed, but also because these " prices " are really the net outputs " associated " in year 0 with one unit of the product used as indicator; to take the example used in Chapter 7 again, we are tacitly assuming that in comparing the outputs of years 6 and 8 each bicycle produced still implies the same amount of spare parts and accessories as in year 0.

If we think of the second approach the most important point is that the effective weights of the series have now been changed, and in particular the effective weights for the subsidiary group index-numbers have been changed. The new weight is, in fact, p_0q_6—the net output* in year 6, measured at the prices of year 0—and the new relatives are of the type $\frac{q_8}{q_6}$ instead of $\frac{q_8}{q_0}$.

* More strictly, it is only an estimate of this, made on the assumption that the movement of the indicator between years 0 and 6 accurately reflected the movement of output, even though it might not really cover the whole field, as with the bicycles, or be defective in some other way.

In effect this process of " shifting the base " is useful if one understands what it implies. It is not, of course, a means of making an out-of-date index into an up-to-date one; even if the weights of the groups were not very different, the indicators used to measure output changes are almost certain to need an overhaul.

The Selection of 1946

It appears from the above discussion that the fundamental criterion for selecting a base year is that the *prices* (or more strictly, the *unit net output contents*) of the various products should be in a sensible relationship. The other relevant points are the ease and accuracy with which the weights can be calculated and the convenience of the selected base for users of the index.

Since the main object of our index is to show the monthly and other short-term movements in output within the period 1946 to (say) 1950 the fundamental test is whether any particular set of "prices" will be appropriate to conditions in that period. This almost automatically rules out the use of any pre-war set of prices, since it is highly unlikely that the relationships which prevailed then will bear much resemblance to the ones prevailing at any time in the period to be studied. The ideal year to choose might perhaps be 1948, which comes in the middle of the period, but that was clearly impossible. It is doubtful whether it would, in fact, have made much difference as against 1946, since the changes in *relative* " prices " have not been great.

These points may usefully be examined a little further. First of all, it is important to stress that the word " price " has only been used as a convenient shorthand for " net output content per unit." It is likely that the relative net output contents of various industrial products will remain more stable over the period 1946–50 than their relative prices, because the effect of violent fluctuations in prices of imported raw materials or agricultural products is eliminated. The net output content may be thought of as the sum of the labour cost per unit and the gross surplus (including overheads) per unit, and the most likely reasons for a major change in the relationships between one product and another are therefore

(*a*) A large change in the relative hourly rates of wages in the two industries ;

(*b*) A large change in output per man hour in one industry, not matched by a similar change in the other;

(*c*) A large change in the relative levels of gross surplus per unit of output.

Without any elaborate discussion we may, perhaps, say that we do not expect British industries to show during this period any general upheaval in their relative levels of wages, output per worker and surplus per unit of output.

Secondly, it may be useful to give two examples to show the effect of adopting a pre-war base year, and so using the relative net output contents which prevailed in (say) 1935. This would, for example, attach a much smaller importance to movements in the output of cotton yarn, despite the fact that the base-year weight of this series would be greater; for in 1935 the levels of both wages and profits in cotton-spinning were much lower in relation to other industries than they were in 1946, and output per worker was relatively higher. On the other hand, much greater importance would be attached to the movements in electricity output, mainly because the gross profit per unit in 1935 was greater (on a much smaller number of units). In effect, the use of 1935 as a base would mean valuing the work of producing 1 lb. of cotton yarn at the relatively low figure which we used to attach to it when the industry was too big for its market, and valuing the work of producing 1 unit of electricity at the relatively high figure which we used to attach to it before the growth of output lowered the real cost of production. If our object is to compare 1935 with 1946 this procedure is as logical as the use of 1946 " prices," as is explained in the next chapter. But for a monthly index over the period 1946–1950 pre-war price relationships are almost perversely irrelevant, because they would reduce the importance attached to most of our bottleneck products (e.g., coal and textiles).

Finally, it is worth emphasizing that " net output content " includes any subsidy paid to the industry and omits any excise duties. We need not be afraid of using 1946 as a base " because prices were then so greatly distorted by taxes and subsidies." The weight of 100·5 attached to beer production, as against 23·9 for wheat milling, reflects the greater amount of industrial activity devoted to the former, not the machinations of the Chancellor of the Exchequer.

The Effect on Group Index-Numbers

There is one respect in which the selection of a more " normal " base year than 1946 would have been a convenience, and that is to the user of the group index-numbers. An index based on 1946 is, of course, quite suitable for showing the movements between any two periods in the activity of a sector of industry, just as it was for industry as a whole. It does not, however, enable one to read off automatically from the table which sectors have a " high " or " low " level of output in any sense that is likely to be relevant. By contrast, the use of an appropriate pre-war base would, for example, have shown automatically which industries were above the pre-war level in 1947.

The strength of this argument must not be exaggerated. It is very rare indeed that any year, or combination of years, is so outstandingly suitable as a standard of comparison that one should encourage its automatic acceptance in all kinds of work. An index-number can never do more than tell us how output has moved between one period and another and comparisons with the base period have no claim to be regarded

as of special economic significance. A cynic might say that it is a positive advantage if the base period is obviously an abnormal one because it forces the user to consider what kind of comparison really is relevant for the purpose in hand. He might well add that the base period has to be *very* obviously abnormal to do much good in this respect, since a single and untypical pre-war year (1938) is almost automatically regarded as the proper standard of comparison in all kinds of British economic analyses—even where it was demonstrably a peculiar year, as with the composition of British exports or the terms of trade.

The constructive conclusion from this analysis is that the index-numbers should be calculated and published with 1946 as 100, but that the table should include figures showing the pre-war position so far as possible. Unfortunately, it is not possible to give complete figures for any pre-war year except 1935, which is not a particularly suitable year, though much better than nothing. This subject is dealt with in the next chapter.

CHAPTER 9

COMPARISONS WITH PRE-WAR YEARS

The calculation of figures for pre-war years to include in the table should not be thought of as simply the extension of the monthly index to cover additional periods. There are two main reasons why it should, on the contrary, be thought of as a separate operation, calling for a reconsideration of the whole field. In the first place, the indicators selected to represent an industry in the monthly index may not be the most appropriate for a comparison stretching over more than a decade, or may not be available at all owing to lack of data. And secondly, there is the logical problem of what set of " prices " or weights should be used in combining the series when conditions in the years to be compared were so different.

Of these two main reasons the first is by far the most important. We must consider in the case of each industry what indicators are the best *for this particular comparison.* If we can get suitable indicators, the weighting problem is a relatively straightforward matter.

The Problem of the Indicators

In pre-war years it would have seemed ridiculous to say that a monthly index of production could be constructed to give better results than a special comparison between the outputs of two relatively close years. The annual computation would have three distinct advantages:

(*a*) It would not be confined to information which is available monthly, but could make use of data which are collected annually, notably at a census of production ;

(*b*) As the calculations would not have to be repeated at high speed every month, they could reasonably be made on a more elaborate basis whenever the data were sufficiently detailed—e.g., the output of cars could be reckoned by horse-power ranges, instead of lumping all these together in one or two figures ;

(*c*) For the same reason, special attention could be paid to awkward industries for which there were no good indicators, but a number of possible clues; the available evidence could be assessed and a broad judgment reached, in a way that would clearly be impossible to repeat every month.

On the other side there would, it is true, be some disadvantages, which become much more acute if the years to be compared are far apart:

(*a*) The composition of an industry's output is much more stable from one month to the next than it is over a period of a decade; consequently, an arbitrary small sample of products for which data happen to be available will usually be a much better guide over a short period than over a long one;

(*b*) The use of employment data to fill gaps is similarly more justifiable in short-period comparisons;

(*c*) Value figures for an industry's output require relatively small adjustments for price changes from month to month, but over a decade or so the price factor may be both large and highly uncertain;

(*d*) Statistics collected from month to month over a short period are more likely to be *comparable* than annual information collected at very different periods.

When we consider the problem of comparing 1946 with some pre-war year, however, we find that the disadvantages attain tremendous importance, whilst the advantages are relatively trifling. The real crux of the matter lies in the question of non-comparability. The war has produced a revolutionary increase in the amount of information collected monthly, which has made possible the calculation of a much improved monthly index. But much of this information has no proper pre-war counterpart, being of a rather different character from the annual information collected at pre-war censuses. This sharp break in the nature of the statistics renders it very difficult to make a good comparison for output as a whole, even with 1935. Comparisons with non-census years can only be of the broadest and most tentative kind, since they have to rely on the pre-war index-numbers to link 1935 to (say) 1938, and we saw in Chapter 2 that these were inevitably very weak.

Other difficulties need to be stressed. The change in the composition of many industries' output has been far greater than one would normally expect over a period of 11 years, and this renders comparisons much more uncertain. Thus the radio industry has been devoting a much greater proportion of its activity since the war to producing navigational aids, for which no statistics are published; in consequence, the output of radio sets is, by itself, a very dubious indicator for the 1935-1946 comparison, even if it is reasonable for a post-war monthly index. This type of error is almost impossible to eliminate unless there is a comprehensive census at both ends of the period to be covered. Even a census is unlikely to reveal the sort of quality shift which may well have occurred within the scope of such statistical headings as cotton piece-goods—e.g., because our output now contains a much smaller proportion of cheap cloth for the Indian market, and a larger proportion of high-grade fabrics.

Finally, one cannot over-emphasize the unsatisfactory nature of the data about price movements, which are needed for indicators based on the value of production. As the rise in price appears to have been over 100 per cent. in most cases the scope for error is obvious.

To offset these difficulties as far as possible one should clearly make the most of the three advantages which still attach to a special annual comparison as against a monthly index—the ability to use additional data which are only available annually, to make more elaborate use of detailed information, and to exercise judgment in the use of miscellaneous scraps of partial information.

The indicators which we used for each industry are set out in the main table in Part II, which also shows the movement between 1935 and 1946 for each one of them. In a good many cases they represent temporary expedients, designed to fill up a gap until something better is available. This " something " may come from two main sources: the publication of more results of the partial census of production of 1946, and further consideration in consultation with trade experts. It would have been a waste of energy to try to produce more elaborate comparisons for engineering (mechanical or electrical) or some of the metal trades by the ingenious manipulation of existing data, when a comprehensive census had been taken.

The partial censuses which had been published at the time of writing (e.g., for hats and caps, printing and publishing, clothing, chemicals) constituted almost the only sources of additional data which were not available for the monthly index. We also made use, however, of the detailed figures for types of iron castings delivered in 1946, which were published by the British Iron and Steel Federation.

Calculations based on the ordinary monthly series were made on a more elaborate basis in some cases where comparable details were also available for 1935; thus separate weights were given to seven different categories of boots and shoes, which the monthly index groups into two, so that due allowance was made for the shifts which took place between categories within these groups.

Finally, in various cases where the data were not very satisfactory we considered the results that would be obtained by a number of possible methods, so as to select a figure which seemed to fit in best with all the available data. The printing and other paper-using industries provided an example where broad judgment was needed. Not only was the information very scrappy, but there were logical difficulties in defining what should be measured, since newspapers and posters had shrunk violently in size, paper had changed its average thickness, and so on. We finally decided to use the movement shown by numbers employed, not merely because it was a convenient and logical indicator of movements in the volume of *net* output, but also because the most plausible use of the other data (paper consumption, newspaper circulations, the census results for general printing and publishing, consumers' expenditure on reading matter *plus* exports) seemed to give a broadly similar result.

Types of Indicator

The following table gives a summary of the proportions of the total weight carried by various types of indicator:

Type of Indicator	*% of 1946 weight*
Production in physical quantity—	
(*a*) involving no significant adjustments	45·7
(*b*) involving significant adjustments	4·4
Value of output, deflated	19·1
Input—	
(*a*) " reliable " series...	5·5
(*b*) " more dubious " series...	4·4
Employment	16·5
Miscellaneous	4·4
Total	100·0

The series were not always easy to classify, particularly if the figure represented the outcome of several approaches, but this table gives the broad picture.

It would not be correct to regard these categories as necessarily implying any particular order of reliability. Thus, the series of " comparable " physical outputs may hide a significant change in average quality—we have never attempted to allow for quality changes within a single heading—or the items used to represent an industry may not have proved typical, or the figures may not, in fact, be as reliable and comparable as their appearance in the *Statistical Abstract* might suggest. At the other extreme " miscellaneous " is normally a euphemism for " no information," which implies that the output of the trade has been assumed to move with that of some other(s); in some cases, however, this should give a reasonably accurate result—e.g., the weight of textile finishing was spread over various textile series in the light of the work recorded at the 1935 census.

An input series has only been classed as " reliable " if the figures for 1935 and 1946 were *both* comparable *and* closely related to consumption by the industry in question. They still suffer from the limitations inherent in all input series (see pp. 34-35).

The employment figures were not adjusted for any change in productivity, and over a period of 11 years this makes them a very dubious indicator for any single trade, even though the statistics themselves should be accurate. Their influence may not, however, be too bad in the aggregate, as they were used for a varied collection of trades, and over the field as a whole changes in productivity seem to be fairly small. For three large trades it should be possible to replace them later by an output series, when the census results are published for electrical machinery, hand tools, and hardware, etc. The largest trade of all for which employment has been used is printing and publishing, which was discussed above.

The deflated value series usually suffer from defects both in the comparability of the values and in the adjustment for price changes. The large items of clothing and drugs, medicines, etc., were, however, based on the census results, and should be reasonably reliable so far as the total value is concerned.

It is perhaps fair to conclude this brief review of the motley collection of expedients which we have used by saying that whilst some of the errors are doubtless large, there seems to be little reason to suspect them of any systematic bias. The danger of getting a downward bias through omitting new products is a serious one, but the most important case (hulls for temporary houses) has been duly included, and so have the medical developments (penicillin, etc.) through the use of a comprehensive value figure. The new products in the radio and electrical field have not been covered, and we decided not to attempt to make any allowance for these until the results of the Partial Census are published. Until then, the rise in output between 1935 and 1946 for this industry will be understated, and there may well be some similar instances elsewhere. In the main, however, it is reasonable to hope that the errors will largely cancel out and leave the final answer to give the right order of magnitude for the change in the total volume of output—so far as this can be measured over such a disturbed period.

Weighting

Little need be said here about the problems of weighting for a comparison of this kind. We saw in the last chapter that the reason why we must expect to get rather different results with 1935 weights from those obtained with 1946 weights is essentially that the relative "prices" (or more strictly, net output contents per unit) of different products had changed. The normal procedure on such occasions is to calculate all the index numbers twice, using both sets of weights, and to take the geometric mean.* This is what we have done, the weights for 1935 being almost all derived from the census of production.

The results of the alternative calculations for each group are given at the foot of its section of the main table in Part II. For the index as a whole the results are as follows:

1935 *Index* (1946 = 100)	*On* 1935 *Weights*	*On* 1946 *Weights*	*Geometric Mean*
"A" Series	96.3	102.6	99
"B" Series	95.3	101.5	98

* See Bibliography [7]. The formula for the index is

$$\sqrt{\frac{\Sigma p_0 q_1}{\Sigma p_0 q_0} \times \frac{\Sigma p_1 q_1}{\Sigma p_1 q_0}}$$

which is classified as index 353 in this reference and was highly recommended by Fisher.

These index numbers show how output in 1935 compared with output in 1946, which is taken as 100. It is perhaps easier to turn them the other way round for purposes of discussion, and we may first dispose of the difference between the "A" and "B" series. Taking the mean figure, the "A" index shows that completions rose by about 1 per cent. between 1935 and 1946. The "B" naturally shows a rather bigger increase, about 2 per cent., because in 1946 a good deal of work went into unfinished houses; if we could allow for the increased work-in-progress in engineering and aircraft manufacture, the contrast would be rather greater.

If we now consider the two calculations for the "A" index, we find that on 1935 weights output apparently rose by about 3 per cent. between 1935 and 1946, whereas on 1946 weights it fell by about 2 per cent. We may repeat that these somewhat different answers do not imply that either result is "wrong." We can only measure total output by valuing the things produced with some set of "prices," and neither year's "prices" have any special virtue for this purpose. The implication of the divergence actually observed is that, on the average, things for which output increased between 1935 and 1946 (e.g., electricity, cigarettes, steel) rose less in "price" than those for which it fell (e.g., coal, cotton goods). Such a result is frequently found in work of this kind, and is indeed likely on *a priori* grounds unless demand conditions change more drastically than supply; it is of importance because the inevitable selection of a past year as the base for a monthly index means that the weighting system gives later figures what might be called an upward bias. This may offset the downward bias which is likely to arise from the choice of indicators, for reasons discussed on page 31.

If we compare the results of the two calculations for the group index numbers we find broadly the same picture of the 1935 weights giving a more "favourable" answer. There are some groups in which all the indicators used (or at least all the important ones) show much the same movement, and in these the system of weighting naturally makes very little difference to the answer. But where there is a significant difference in the two results, it is always in the same direction.

The group which was most affected was fuel and power, for which the rise in output was shown as 27 per cent. on 1935 weights, but only 4 per cent. on 1946 weights. This provides a very good illustration of the factors involved, since it is mainly due to two outstanding items, coal and electricity.

It is well known that the average price per unit of electricity did not rise during the war like other prices, despite the rising cost of the coal used to make it; the net output content was consequently some 20–25 per cent. *lower* in 1946 than it was in 1935. With coal, on the other hand, the net output content of each ton had risen by about 175 per cent. Consequently, the number of units of electricity regarded as equivalent to a ton of coal for index purposes was more than three times as great when using 1935 weights as when using 1946 weights.

Even this startling change in our scale of relative values would not make any difference to the result if the outputs of coal and electricity had moved similarly, but, of course, they did not. The tonnage of coal produced (including open-cast) fell by 14 per cent., whilst the output of electricity rose by 127 per cent. The 1946 scale of values says that these two movements about offset one another; the 1935 scale says that the combined output has risen by over 25 per cent.

Some Notes on the Implications of the 1935 Comparison

One half of our comparison between 1935 and 1946 is based on 1946 " prices," and it is of some interest to speculate on what the result would have been if there had been a free market in that year—i.e., if prices had not been controlled, and purchasers had not been restrained by rationing, allocations, etc.*

The problem is not, of course, free from ambiguity. We must assume the same output of each article, but the abolition of controls almost inevitably implies some other action to deal with the situation, and the effect on relative prices depends on whether we assume this to consist mainly of (say) increased taxation, or violent credit contraction, or great borrowing abroad. Even if we assumed no *conscious* policy, the concept of leaving things to take their course can be very differently interpreted in circumstances of this kind.

One presumption is, however, sufficiently strong to justify an examination of its implications. If a free market were introduced with unchanged supplies we should expect, whatever else were done, that the prices of things in really short supply would rise relative to those for which there had been some approach to equilibrium. " Really short supply " in this context is not synonymous with a 1946 output below the 1935 level, but clearly the two will largely go together. In the case of coal and electricity, for example, the supply of coal was much further below the level of (unfettered) demand at the controlled price than was the case with electricity, for which restrictions only applied at peak periods; indeed, if would-be buyers (including foreigners) had been allowed to bid up the price of coal and there had been no artificial incentive to switch to electricity, the supply of the latter might have exceeded the demand. Similarly with textiles and cigarettes, the low output of the former would probably have implied a relative rise in price in a free market, and the high output of the latter might have exceeded demand.

We saw above that, even with controls, there was a general tendency for " prices " to have risen more in cases where output had fallen than in cases where it had risen, and that this was the reason why the comparison based on 1946 weights showed a fall in output between 1935 and 1946, although the " 1935 " calculation showed a rise. With a free market this

* For a general theoretical discussion of problems of this kind, see Bibliography [8], especially Chapter VI.

tendency would have been accentuated, and the " 1946 " calculation would have shown a bigger fall in total output.

This result is, of course, in accordance with common sense. A comparison based on hypothetical free market " prices " instead of actual controlled ones would attach more importance to things for which output had fallen, and relatively less to those for which it had risen. It is perhaps a useful warning against rejecting the use of 1946 " prices " and confining the comparison to 1935 weights, " because prices were controlled in 1946 and conditions were so abnormal." The result would be to make no allowance for the distortion of output in 1946, instead of a partial one.

On the assumption of a free market it is possible to explore some of the implications of the fact that the comparison based on 1935 weights showed a rise in output between 1935 and 1946 and that based on 1946 weights a fall. We cannot give any real answer to the question whether the 1946 output was more or less " valuable " than the 1935 one in some ultimate philosophical sense, nor yet say whether the nation would have been " better off " in 1946 if it had produced the same things as in 1935. We can, however, explore some of the implications from the point of view of the group of people who buy the things which finally emerge from the industrial machine, though our conclusions must be largely negative.

It is perhaps as well to emphasize that the purchasers of British output are a somewhat motley collection, including, for example, industrialists buying capital equipment, foreigners buying our exports, railways buying coal and power, and farmers buying fertilisers, as well as distributors buying for re-sale to the British consumers. The philosophical basis for our discussion will not, therefore, be as clear as in the classic analysis of such problems by Hicks,* who was concerned with the purchase of final goods and services by ultimate consumers.

The question at issue is whether or not the results which we have obtained necessarily imply that the " tastes " or " preferences " of the purchasers have changed in such a way as to render meaningless any comparison of the value to them of the two assortments of goods. We would have been forced to this conclusion if the two comparisons had given the opposite results, i.e., if we had found that:

$$\Sigma p_{35}q_{35} \text{ was greater than } \Sigma p_{35}q_{46}; \textit{ and}$$
$$\Sigma p_{46}q_{35} \text{ was less than } \Sigma p_{46}q_{46}.$$

For the first result implies that the 1935 assortment was definitely preferred by the consumers in 1935, since the 1946 assortment would have cost less and yet they, in fact, bought the 1935 one; whilst the second similarly implies (on the assumption of a free market) that in 1946 they preferred the 1946 assortment. The consumers as a body must have changed their

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* See Bibliography [9], and the discussion in [10, 11, 12].

views, probably because their circumstances have changed and the distribution of purchasing power has changed.

Our actual results, however, do not *prove* that there has been a change of this kind, though there may well have been. Take, for example, the "1935" calculation, which showed that

$$\Sigma p_{35}q_{35} \text{ was less than } \Sigma p_{35}q_{46}$$

We cannot be sure from this that the purchasers would have preferred the 1946 assortment in either year. All we know is that it would have cost more in 1935 than the things which they did buy, and this can at most only imply a presumption that they might have preferred it; the test was not made, and in this case we may well feel sceptical about the presumption.

Similarly the "1946" calculation showed that

$$\Sigma p_{46}q_{35} \text{ was greater than } \Sigma p_{46}q_{46}.$$

This does not *prove* that in 1946 purchasers would have preferred the 1935 assortment, as many of them had adjusted their arrangements on the basis of the changed supplies (e.g., had mechanised their farms, installed electrically driven appliances or even electric locomotives). The presumption that they would have welcomed a return to the 1935 assortment is not as strong as it might appear.

This last point is one which is of some importance. Our habits and installations are naturally more in tune with today's supplies than with those prevailing a decade ago; we have become dependent on the higher output of electricity and of spares for tractors, whereas these things might have been useless in 1935. Consequently, there will be a natural tendency for purchasers in each year to prefer the assortment which they, in fact, get to a drastically different assortment which seemed to be equal on a statistical test.

It is something of a paradox that the use of 1935 "prices" in the statistical test says that output was lower in that year than in 1946, though we may suspect that purchasers would have resented being made to change to the other assortment; but the same thing also applies the other way round, and is probably a general phenomenon. The fact that our statistical results do not prove that consumers' views have changed must certainly not be interpreted as proving that they have not.

CHAPTER 10

PROVISIONAL FIGURES AND REVISIONS

One of the main functions of a monthly index is to enable people to keep abreast of recent developments, and it is therefore important to produce the current figures as quickly as possible. The effort to provide an up-to-date measure of production, however, comes up against three difficulties:

(*a*) The slowness with which some figures are collected and published;

(*b*) The use of periods longer than a month. Thus if figures are collected as quarterly totals, there may be no figure on which to estimate January's production until May or June;

(*c*) The frequent revision of the basic statistical series by the authorities responsible for collecting them.

The result of (*a*) and (*b*) alone may be that twelve months pass before the data are strictly complete; while (*c*) means that figures several years old may at any time be revised. On the other hand, well over half the data (measured by the "weight" they represent) are available by five weeks from the end of the month to which they relate; and nearly all the important series are available within nine weeks.

Clearly it would be foolish to wait for perfection; some principle must be adopted for estimating series which arrive late, even though this will entail some revisions. We have decided that if, five weeks after the end of each month, data are present for more than half the constituent items of a group (measured by their weight), we are justified in estimating the remainder to give a provisional index for the group; but if less than half the items can be covered, no separate estimates of indicators are made, and no index for the group is published for that month, but the aggregate "net output at 1946 prices" is estimated for the whole group and used to calculate the total index.

In making these estimates we could adopt one of two principles. We could make a mechanical assumption that the missing series would show the same movement as the indicators within the same group which *are* known quickly (or, where a whole group is to be estimated, as other groups which are more fully known). This would raise the problem of the period to be used for reference purposes—one must obviously choose a recent one, but to use the latest month by itself might produce serious errors if the missing indicator had been at a peak. It is, however, difficult to justify the principle logically, whatever period we use. For instance, why should the output of fabricated aluminium be assumed to move from month to month with that of raw and finished iron and steel? Some investigations we have made do, in fact, show that the use of

" early " indicators to estimate late ones will in several instances introduce a bias into the estimates.

At the other extreme we might ignore the figures for other series and have regard only to the previous history of the indicator in question—in fact, extrapolate its trend, subject to such variations for holidays, etc., as its history in previous years shows to be likely to occur.

Our actual practice is much nearer to the second principle, but we early decided that a mechanical procedure for determining and extending the trend would be a waste of time, since the other causes of variation are relatively so important. We thus fall back on enlightened common sense; that is, on the making of estimates for each series separately on the basis of a general judgment of likely movements as revealed by recent figures for that series and a general impression of what has happened in that month in other industries. The amount of care with which the estimate is made can be varied according to its weight.

The more violent movements of the economy have often caused estimates to be wrong in detail, but we do not yet find any tendency to err systematically in one direction. It must be remembered, too, that many of the indicators to be estimated are unimportant, and quite large mistakes in the estimates often have a negligible effect upon the group and total indices.

Boldness in calculating provisional index-numbers necessarily implies that the figures for recent months must be revised when the missing data become available, since these are needed for assessing the recent developments. When the series used are revised, we apply the revision at once to the last six months; earlier figures we can only revise occasionally, when some general revision of the index is in hand. The 1935 comparison, however, is kept constantly up to date in the light of the latest information. This calculation is an important and separate one, and a powerful practical argument against expressing our results on the basis of 1935 as 100 is that changes in it are likely (see page 66) and these would then require revision of the figures for every month.

CHAPTER 11

LEARNING FROM EXPERIENCE

This chapter is intended to illustrate the working of the principles set out in Part I by the most revealing method—a discussion of some of the errors which, on looking back, we can see that we have made, or which we only just avoided. If we could have read the book first we would have made fewer errors, and an account of our failings may help our successors as well as show how various principles interact.

Selection of Indicators

This is the most important part of the work, and we have undoubtedly been over-influenced by the particular way in which productive activities were classified into industries by the census. We would have done well to begin each discussion by reciting the first golden rule :

> *Rule* 1. Each £1 million of net output requires the same care in consideration, whether it be a small part of a large industry or the whole of a small one.

Almost inevitably one pays too little heed to reducing the likely error in measuring a large industry's output from (say) 4 per cent. to 3 per cent. as against reducing the error for an industry one-tenth its size from 40 per cent. to 30 per cent. For example, we accepted the production of gas by the gasworks to measure the movement in the whole of their net output, including that represented by the coke and by-products. In effect, we were assuming the output of the coke, etc., to move with the output of gas, and if all our assumptions had been as reasonable as that one we would have felt very happy. Nevertheless we ought not to have been satisfied *in view of the large net output at stake*, and the ready availability of a better indicator for the coke in the shape of actual production figures. The introduction of a separate series for coke would have done more to improve the accuracy of the index than we could hope to achieve through many of the series which carry a small weight.

How could we have tested this ? The answer is fairly clear in such a case. The 1946 net output attributable to coke was about £25 million, and we should have tried to assess the difference, in absolute amount, which would be likely to be made to the corresponding figure for some other period by using the " gas " movement as indicator instead of the " coke " movement. Strictly speaking, this depends on an assessment of the variations in the coke/gas ratio which are reasonably likely *in future*, but one can get some guidance from past statistics, and should then perhaps add on something for contingencies. One should find the

months in which this ratio was at its extreme values, but for exposition we will take the 1935 figures. The coke output was then 81·8 per cent. of 1946, and the gas output 74·5 per cent. The figures which we would use for 1935 in our calculation (*i.e.*, the estimated value of 1935 output at 1946 prices) would therefore be

Using coke as indicator	20·45
Using gas as indicator	18·62
Difference	1·83

It is the *absolute* size of the difference to the result made by using the "coke" indicator which is the key criterion. It depends, as explained in Chapter 4, on the product of two factors—the "weight" of the products concerned, and the likely divergence in movement of the two indicators.

By way of contrast we may take the small census trade of incandescent mantles, for which we introduced a separate series although its weight was only 0·3. There is no obvious alternative measure of output for this industry—nothing seems to be at all closely linked with it—so that there is no case for giving its weight to some other series. If we are to regard it as within the scope of the index, the choice is really between introducing the series and so-called omission, *i.e.*, assuming its output to move with industry as a whole (see page 18). The latter procedure would, up to now, have given a figure which would always have been between 0·25 and 0·4, and is unlikely ever to reach 0·5. Using the series might perhaps produce a figure as low as 0·2, but it is hard to imagine it rising above 0·5. The highest error which is really at all likely, therefore, as a result of omitting the series is 0·2, which is far smaller than the error caused by the (very plausible) assumption that the gasworks' output of coke and gas would move similarly.

How did we come to make this silly mistake, and what reasonable precautions would have avoided it?

The principal explanation is that we thought too much of the census industry as the unit, instead of £1 million of net output or even particular products. If we had squarely posed the question "what is the best indicator for the large block of net output represented by coke," we would almost inevitably have said "coke production," but we thought of the problem too much as one of finding indicator(s) for the gas industry. The output of gas seemed a very good one, and a separate series for coke rather a luxury. We under-estimated the percentage divergence of the indicators, and did not fully allow for the great care needed where a large weight is at stake.

The best method of avoiding such an error would undoubtedly have been to work out all the principles really fully before we started, and to attempt to fix some quantitative standard for the sort of likely error which justified either the introduction of an additional series to remove it, or some equivalent amount of work.

The sort of figures involved may be seen from our index. The total of the weights, as computed, is £3,270 million ; this would usually be known at the outset from the census of production, but with 1946 as base needed a special computation. Consequently, if the introduction of a new series is likely to make a difference to some future figure of about £3 million, it will move the combined index by 0·1 points. The " coke " series would about conform to this test, since variations in the coke/gas ratio might well exceed those used in the example given above.

We must, however, also consider the group index numbers. For a typical small group the weight is about £100 million, so that a difference of £1 million would move it by one index point.

We might then adopt the standard that a likely error of £5 million calls for a vigorous search for some better indicator(s) ; an additional series should be introduced if it is likely to reduce the error by £1 million ; series which are unlikely to make a difference of more than £½ million are probably unnecessary luxuries.

The important part of these rules is of course the part dealing with elimination of errors which are absolutely large. Reduction in the number of series with small weights does not improve the index, it merely saves computing time. We cannot adopt an inflexible rule about rejecting series with a weight of less than £1 million, as witness the case of maize discussed on page 60, where the weight is only 0·2 but the difference to a later month has already reached 1·0 ; it would have been useful, however, to insist that an industry with a net output of less than £5 million should not normally have more than one indicator, unless there is very clear reason to the contrary. We had some such idea in mind when we ruthlessly added all types of brushes together to make a single indicator for the industry (weight £4·8 million) on the grounds that any variation in the proportions of the more (or less) valuable types was unlikely to have a sufficient influence on the result to justify a separate indicator. On the other hand we used three separate indicators for the sports goods industry (total weight £4·1 million), and the argument that the movement was likely to be very different, though true, is perhaps insufficient to justify such a luxury when the weight involved was so small compared with that of other industries which were more summarily treated.

At the other end we should of course have treated the big industries very carefully, with no preconceived ideas of limiting the number of indicators used for an industry to any specific figure : the background idea should rather have been that the average weight per series was only going to be about £10–15 million, so that we would be lucky if we found many series which could properly carry a weight of more than (say) £30 million. There is, of course, no inherent objection to a series having a big weight if a large sector of production can be better represented by that single indicator than in any other way. If, however, the weight is big, then the introduction of a second series is justified even if it is likely to show a fairly similar movement, provided that the differences will probably be improvements ; one must therefore be ready to use separate

series for (say) tankers and other ships rather than a single one for all vessels, even if the percentage difference between their average net output contents per ton were smaller than that between the average net output contents of a broom and a toothbrush (which we added together in our total number of brushes).

Indicators with Large Weights

Finally, when the first list was complete, there should have been a special scrutiny of those indicators with a weight of more than (say) £50 million, to see whether the activity in question could be more accurately represented by using more than one series. We have 16 indicators in this class, and a few notes on the results of such a scrutiny are revealing.

The largest weight is carried by coal production—no less than 291, or considerably more than all the 76 indicators with a weight of less than 5 put together. (A frequency table of weights is given on page 119.) The only question here is the treatment of opencast coal. Our procedure is simply to use the total tonnage of coal produced as our indicator and in calculating the weight we increased the estimated 1946 net output of the ordinary mines proportionately to the tonnage. From the scraps of information which have been released about the cost of opencast operations it is likely that the net output content per ton of opencast coal in 1946 (which should include the subsidy) was considerably *higher* than for deep-mined, so that logically we should have had a separate series for opencast coal with a higher weight than the £14 million or so which we added to the mines' figure. There is however something rather repugnant to commonsense in thus treating (inferior) opencast coal as more " valuable " for index purposes, so that total output would be recorded as higher if mined coal fell by 1 million tons and opencast rose by 1 million. Our decision to use total tonnage as the indicator was admittedly made without adequate realisation that opencast coal was a sizeable industry, even if only some 5 per cent. of deep-mined, but its results may be considered acceptable. We should, however, have raised the total weight attributed to coal to allow for the higher net output content of opencast ; the result would still have been below the figure arrived at under free market conditions.

The second largest weight (270) is carried by the deflated value figure for 25 types of machinery. In a sense this is not one series, but 25, the only common element being the price factor used to deflate the value figures. The obvious comment is that greater accuracy in this factor (which is simply the average value index for machinery exports) would pay a handsome dividend since it is applied to so large a weight. In the absence of proper data on machinery prices, however, we know of nothing better than this unsatisfactory device. A specially compounded index of published wage rates and material prices seems likely to give even worse results, unless done with extreme care, if only because the value figures

relate to machinery constructed over varying periods of time in the past, and no allowance can easily be made for changes in efficiency or in the ratio of prime costs to overheads and profit. It seems essential to use figures relating to completed machinery even if they are not really on the right basis, and the only ones now available are export average values. It might be possible to make better use of these by combining figures for different types of machinery in the same sort of proportions as the types produced, and in view of the amount at stake this seems worth exploring.

Only one other indicator carries a weight of more than 100, and that is beer production (in bulk barrels). Theoretically this could be improved fairly substantially if the output were divided between bottled and draught, since the net output content per gallon is considerably higher for the former, but the information is not available. As explained on page 31, the use of standard barrels instead of bulk barrels would not be an improvement since changes in average alcohol content do not reflect changes in average net output content.

Of the other large series, the most illuminating is our cavalier treatment of the problems posed by the main group of iron and steel industries. The total weight to be attributed to the group was £127·6 million and this large figure deserved very careful consideration. In effect, however, we ignored the differences in the amount or kind of processing which a ton of steel might undergo within this group, and simply split the weight between two series—the output of steel ingots and castings, and the net deliveries of finished steel (other than for conversion into some other type of finished steel).

In a broad way the above combination is a good one : it largely measures the same thing (at a slightly different stage) but the second allows for work done on imported ingots and the like, so that a ton processed in this way virtually counts as half a ton of all-British steel. In an index which was only to comprise (say) 50 or 100 series the selection could be applauded. But if we were prepared to have 200 indicators (based on a much larger number of series) and to include 76 with a weight of less than 5, then we should have paid more regard to the different types of finished steel, for which the average net output content per ton varies. A rough inspection of the figures suggests that so far our crude method has not caused any serious error, because the movements in the output of the various types have not been sufficiently different, but this may not always be so.

The last statement illustrates the fact that of the two causes of error associated with physical production series*, *inadequate analysis* is usually less serious than *incomplete coverage* of all the products. With steel we have not split the total tonnage by types, so that a shift from less valuable to more valuable types does not affect the index ; but the average " prices " (more strictly, average net output contents per ton) for the different output categories are all of the same order of magnitude, so that

* See page 28.

it needs a markedly greater rise in the output of the more valuable types to make much difference. In the case of coke and gas no heed at all was paid to the coke figures, so that even a moderately small difference in the movements for coke and gas affected the result significantly.

The Comparison with 1935

The main lesson to be learnt from a review of this part of our work is that we did not fully live up to our principle of treating it as a separate operation from the monthly index, calling above all for reconsideration of the indicators to be used. By comparison with this the need for using the double system of weighting might be considered a rather pedantic matter.

In a good many cases we did use more elaborate calculations, as the table in Part II shows ; for example, we just realised in time that we ought to introduce the coke series into the calculation for gas undertakings, and for various industries (*e.g.*, motor vehicles, boots and shoes) we used more detailed figures for types. We did not, however, pursue this elaboration as far as we might have done, largely for the legitimate reason that we had been asked to complete a provisional calculation as soon as possible. We ought however to have recognised the importance of improving the accuracy of our indicators for the big industries (*e.g.*, the steel group, paper making) since the scope for error was so much greater in a comparison between two years separated by a war, and a more elaborate method only required one detailed calculation. In particular we did not show sufficient persistence in trying to extend our coverage of products—*e.g.*, by introducing figures for wool tops (to reflect those which are exported, and so not covered by the worsted yarn output) ; the amount of comparable data available for this purpose is, however, small.

A more debatable point concerns our decision not to attempt any allowances for changes in the average quality of the goods coming under one statistical heading, *e.g.*, women's shoes with leather uppers. In a sense this is contrary to our general principle that calculations should be reduced to their elements (*cf.* Chapter 4) and that rough estimates of these are better than nothing, provided you are reasonably certain that you have reduced the residual error. Moreover it would be fallacious to plead that we could do nothing because in many cases our knowledge was insufficient even to state the direction of movement. We could have met this argument by quoting the second golden rule :

> *Rule* 2. There is no reason why some errors should be left uncorrected because one cannot correct them all.

On the other hand the job would have been a most formidable one, and the results would have been more difficult for the user to appraise ; he would have had no knowledge of our unconscious bias, even if he were convinced of our impartiality. If we had thought that the corrections

should be predominantly in one direction we might have essayed the task, on the principle that the more or less random errors introduced by our guesses were better than a systematic bias ; but we do not accept this theory, and the effect on our final result might have been in either direction.

Finally, we did not seek sufficiently for alternative measures to serve as a check on some of the dubious elements. In view of the amount at stake, for example, we might well have tried to find some other measure of the price rise for the machinery group, but we decided to await the publication of the census results. In other cases we might have sought for input series (for which it is often possible to secure fairly comparable and comprehensive data) to serve as a check on output series which did not fulfil both these conditions.

Industry Weights

Two bad decisions which we made about the estimation of 1946 net outputs of the various industries are of some value as illustrations of principles.

First, we decided to ignore the small firms when basing our calculations on the 1935 census, instead of estimating their net output on the basis of their numbers employed. This point has been discussed in Chapter 7, and is only mentioned here on account of the fallacious argument which had a good deal to do with our rather hasty decision. This was that monthly output returns are not usually obtained from small firms, so that they would not be reflected in the indicator, and should not be included in the weight.

The first fallacy in this argument is simple, and shows the need for considering indicators and weighting together ; nearly all the important cases are represented by *input* series (*e.g.*, *tailoring*, *etc.*, by cloth supplied for civilian clothing, *baking* by flour for U.K. food, *printing* by paper consumption) and these input statistics represent the total supply of the material becoming available whether used by big firms or small (or indeed by the housewife) ; other " small firm " industries have employment as their indicator, which again covers the whole industry. There was, therefore, no justification for assuming that the small firms would not affect the indicator, but even if there had been the argument would still have been worthless. For unless we were prepared to define the scope of the index as excluding the small firms there is no escape from assuming their output to move in *some* way, as we saw in Chapter 4. " Complete omission of the weight " is tantamount to assuming it to move with output as a whole, and this would seldom be as plausible as assuming it to move with that of larger firms in their own industry. We might invent a third golden rule to remind us of this kind of point :

> *Rule* 3. It is no good reducing the weight of a series because it is a bad indicator unless you give it to something else which is a better indicator *for the activity in question.*

The second bad decision in calculating 1946 net outputs illustrates the danger of taking short cuts without considering the full consequences. We had decided to start from the 1935 net outputs, and assume each of these to move with the aggregate wage bill of insured workers in the industry. For 1935 it was clearly necessary to calculate the average numbers in employment carefully, using the unemployment figures for each month in the year. As it happened this lengthy job had been done for every industry in another connexion, but on the basis of workers aged 16–64, whilst the 1946 figures included the 14's and 15's. We decided however to use the figures as they stood on the ground that as the weighting system only depended on ratios between the various industries a common error would not make enough difference to justify the work of adjustment, especially as the whole basis of the estimate was a very rough one and great precision in weighting was not necessary.

This would have been a bad decision even if we had in fact only wanted to use the results in the form of ratios. Rule 2 may be extended to say that there is no justification for introducing avoidable errors into an estimate merely because other unavoidable errors are probably larger ; the most that could be added as a rider is that if the avoidable errors will not really be very important, or the labour of avoiding them is disproportionately great, then the work need not be undertaken. In this case the omission of the 14's and 15's raised the estimated net outputs for the industries to which the wage-bill method was applied by an average of about 8 or 9 per cent., and the variations about this average were far too great to justify our ignoring their effect on the ratios.

The awkward results did not, however, stop there. We later found that the wage-bill method was not suitable for some industries, or that a better one was available (see Chapter 7 and the table in Part II). These other methods naturally did not share in the upward bias, and the weights given to these industries are in consequence too low. Furthermore the 1946 net output figures are sometimes of interest in themselves, even though they are such crude estimates ; they are useful, for example, for assessing what part of the national income is covered by the index. It is annoying to have to start the assessment by allowing for the upward bias in some of the estimates.

If we had investigated the position properly we might have decided that a rough allowance would suffice, based simply on the numbers of 14's and 15's in July, but some allowance was clearly necessary. It is unwise to allow figures to get on to a definitely wrong basis, so that they have a systematic error.

Weighting within Industries

In the division of industry weights between various indicators our mistakes, or near escapes, mostly illustrate the need to think firmly of the 1946 position rather than the 1935 one, and this non-recurring problem calls for little elaboration. We may perhaps mention the maize case once

again, however, as an illustration, where we first put the weight rather casually at 0·5 out of the grain-milling total of 24·1 ; this seemed small enough to serve as a sort of token weight, but we realised in time that it had to be fixed properly at the low level of 0·2 implied by its indicator, since the series was to show a sixfold rise.

When it was a question of distributing the uncovered part of an industry's output over the available indicators on the basis of hope alone our decisions usually showed the powerful attraction of spreading the weight proportionately to the net outputs directly represented by these, despite the absence of any real logic behind this principle (see page 54). Our treatment of the mechanical engineering trade, as defined by the census, does however illustrate some more important points. Here our indicators consisted of a number of quantity series for specific things—*e.g.*, locomotives, coal cutters—and the deflated value series for 25 types mentioned above ; these left a considerable part of the trade uncovered, and our first instinct was to calculate proper weights for the specific items and give all the rest to the large value series. This rather anonymous indicator seemed a plausible one to take for the miscellaneous engineering products with no statistics, perhaps partly because of the " sample " idea discussed in Chapter 4, whereas there seemed no logic in saying that anything would tend to move with locomotives. This logic is, however, spurious, as we can see by thinking of some specific kind of " uncovered " machinery (*e.g.*, chemical machinery). Our first instinct would in effect have divided the weight of this between the 25 types, but given none to the locomotives. There is, however, no *a priori* reason for saying that the output of chemical machinery will move more nearly with that of hosiery machinery than with that of locomotives. There is indeed no *real* reason for saying that it will move at all closely with anything, and we only justify giving its weight to other engineering products at all because there are more links with these than with most other series, both on the supply side and the demand side (steel supply, labour supply, investment programmes, etc.).

How, then, should the problem be tackled ? The first thing, of course, should be to see whether some of the uncovered part has a closer connection with the indicator(s) for some other industry than with mechanical engineering. We realised, rather late in the day, that marine engineering was much more likely to move with shipbuilding than with other types of machinery, and transferred its weight accordingly. For the 1935 comparison we also assumed constructional engineering to move with the building and contracting indicator, but in the monthly index we have no really suitable indicator there, and steel supply provides a fairly important link with mechanical engineering in the post-war period ; so we did not disturb our original decisions in that respect, as the gain in accuracy seemed dubious

This still left a large amount of uncovered output. One objection to giving its weight mainly to the deflated value series, which we probably under-rated, is that this intensifies the already great effect of errors in our

very uncertain deflator. There is, however, no reason whatever to give a very heavy weight to the locomotives, coal-cutters, etc., which are mostly subject to very special influences. Almost inevitably we were driven back to something like the " pro rata " principle—find the " proper " weights for all the indicators, and spread the total in roughly those proportions. It provides a pseudo-logical way of making what is essentially an arbitrary decision, and appears to let our ignorance be a neutral factor.

The Effect of Errors

It is perhaps right to conclude this chapter by emphasizing the point made at the beginning : it has been written to provide some forceful illustration of the principles discussed in this part, and in no way to provide an appraisal of the accuracy of the figures published as the London and Cambridge Economic Service Index. To do this latter task at all properly would require an immense amount of labour, and in many respects is impossible for lack of data. We would like to stress, however, that the errors discussed in this chapter are unlikely to have any serious effect on the usefulness of the index for its basic purpose, which is to give an indication of the movements of industrial output from month to month over a period of perhaps five years.

The accuracy of an index for such a purpose depends primarily on the suitability of its indicators to represent the activity which they purport to cover. Our main error of judgment in this respect was to devote too much energy to counting the petty cash relative to that spent on the bigger items. The main consequence of this, however, is an unnecessary amount of computing work : over a period of five years or so the extra indicators which we might have introduced for the big industries would probably show a fairly similar movement to those used. Moderate errors in the weights of the kind described above are unlikely to have any really significant effect on the short-period movements of the index, since it is most unlikely that they would be sufficiently correlated with disparities in the movement of the indicators.

PART II

THE DETAILS OF THE INDEX

The following table shows the detailed construction of the Index. The first column sets out the titles of the Trades or parts of Trades of the 1935 Census of Production which are " covered " by the Index ; below each title is the corresponding 1935 Net Output (excluding small firms), and Appendix 1 reconciles the total net output covered with the net output of all Trades of the Census of Production. The Central Statistical Office issued (1948) a *Standard Industrial Classification*, which will be used for future Censuses ; it is divided into 24 Orders and 163 Minimum List Headings, and the second column of the table following shows the Headings or parts of Headings most nearly corresponding to each indicator or set of indicators. The correspondence is not exact, and many minor items of output are not of course directly reflected by an indicator. Appendix 2 sets out the complete Standard Classification, and shows whether each Heading is covered by the Index, and where in the Index table it may be found.

The third and fourth columns of the table show the reference number and content of each indicator. Most of the indicators are obtained from the *Monthly Digest of Statistics* or other published sources ; where the 1935 indicator is found in a different source a note is usually added, and care has been taken to secure comparability. The fifth column gives an approximate ratio of 1946 to 1935 output (by volume) for each indicator, and should be read in connexion with any notes on the 1935 comparison. The letters of the sixth column refer to the notes at the end of the table, and show how the weights used in the monthly index have been derived. These weights are set out in the seventh column and minor notes on method and content are in the last column ; longer notes are included among the lettered items at the end of the table.

The indicators used for the 1935-46 comparison are identical with those used in the monthly index except where the notes indicate a divergence. At the end of each of the thirteen Groups into which the Index table is divided the results of the 1935 comparison are set out, as calculated with 1935 weights and with 1946 weights ; in the Table of the Index the geometric mean of these two figures is shown.* The classification of the indicators in a group by types is also given, and Appendix 3 summarizes this information for the whole Index. It will be noted that about 12 per cent. of the weight in the monthly figures, and about 16 per cent. in the 1935 comparison, is represented by employment series ; this will damp (though it will not obscure) any general trend of productivity per head. Appendix 4 shows the frequency distribution of the weights.

References to Ministry of Labour industries are to the titles of those industries as used in January, 1948. "n.a." means " not available."

* See page 68 for the ' total ' index on the two weighting systems.

TRADE as defined in 1935 Census of Production (1935 net outputs in brackets).	Minimum List Headings.	Reference No.	INDICATORS USED (Production unless otherwise shown).	Approximate Ratio of 1946 to 1935 Output (by volume).	Method of Obtaining Weight.	Weight	NOTES.
1. Textiles.							
Cotton spinning and doubling (£20.2 mn.).	110	1 1	Single cotton yarn up to 26s *plus* waste yarns (lb.).	0·71	B	15·9	The weight for the sub-group includes 3·2 from Finishing (see below). For the 1935 comparison the weight for doubled yarn was spread over the single yarn classes, there being no comparable data for doubled yarn in 1935.
		1 2	Single cotton yarn, 27s. to 80s	0 45	B	14·1	
		1 3	Single cotton yarn, over 80s	0 59	B	3 0	
		1 4	Doubled cotton yarn, total.	n.a	C	8·2	
Cotton weaving *less* Cotton smallwares (£19 6 mn.).	111	1 5	Woven cotton fabrics (linear yards).	0 53	A	40·2	Including 13 4 from Finishing (see below).
Woollen and worsted *less* Carpets (£37 9 mn.).	112	1 6	Total deliveries of worsted yarn (wool content) (lb.).	0 66	A	23 0	The weight for the sub-group includes 3·0 from Finishing (see below) and was split according to estimated 1935 net outputs. In the 1935 comparison blankets were taken separately.
		1·7	Total deliveries of woven wool fabrics *plus* wool blankets (linear yards).	0 85 (fabrics) 1 01 (blankets)	A	37 9	
Carpets (£5·6 mn.).	120	1 8	Wool carpets and rugs—total (square yards)	0 45	A	4 8	
Silk and Artificial Silk .							
(i) Rayon, nylon, etc., production ("Artificial Silk Manufacturers") (£7·3 mn.).	113	1 9	Rayon—continuous filament yarn—single (lb.).	1 00	B	10 0	
		1 10	Rayon—staple fibre (lb.)	6 44	B	1 9	
(ii) Silk throwing and spinning, and the "Silk" section of "silk and artificial silk weaving" (£1·5 mn. est.).	114 (part)	1 11	Consumption of raw silk (lb.)	0 15	D	0 5	The weight for (1·11) and (1·12) together includes 3 0 from Finishing (see below).
(iii) Rest of Census trade (*i.e.*, rayon weaving and sundries) *less* smallwares (£4·6 mn. est.).	114 (part).	1 12	Woven rayon and cotton rayon mixture fabrics (linear yards)	1 02	D	12 1	
Linen and Hemp (£7 1 mn.).	115	1 13	Consumption of flax (tons).	0 60	A	15 9	Including 1 0 from Finishing (see below). The 1935 consumption figures were obtained from the average of three years' imports, including tow, plus home production; the corresponding 1946 figures being based on home production and imports corrected for stock changes.

Jute (£2·9 mn.).	116	1 14	Consumption of raw jute (tons).	0 57	A	4 3	The 1935 comparison was obtained in the same way as for linen ; there being of course no home production.
Hosiery (£17·3 mn.).	118	1·15	Total production of socks and stockings (no.).	0·73	A	12·1	The weight for the sub-group was equally split between the two indicators. It includes 2·4 from Finishing (see below).
		1 16	Total production— Men's pullovers and cardigans, vests, pants and trunks *plus* women's jumpers and cardigans, vests, knickers and pantees *plus* children's outerwear and underwear (no. of articles).	0 75	A	12 1	1935 figures estimated from the Census.
Textile Finishing (£18·4 mn.).	123 (part)		None (see notes).	—	A	—	The weight (26 0) was obtained by using the earnings ratio for "Bleaching, printing and dyeing." It was then spread (as indicated in notes above) over the cotton, wool, linen and hosiery trades in proportion to the 1935 net outputs of the corresponding subdivisions of the Finishing industry.
Lace (£2 8 mn).	119 123 (part).	1 17	Employment, Lace industry	0 42	A	2 4	
Rope, twine and net (£2 2 mn.)	117	1 18	Consumption, soft hemps *plus* home consumption, hard hemps (tons).	0·99	A	5 5	The 1935 comparison was based on the average retained imports of three years (including tow and codilla), compared with 1946 imports corrected for stock changes.
Canvas goods and sack, Asbestos goods and engine and boiler packing, Flock and rag, Elastic webbing, Coir fibre, horse-hair and feather, Roofing felts, Textile packing, *plus* Cotton smallwares and Rayon smallwares (omitted above) (£10·1 mn.).	121 122 123 (part). 129	1·19	Employment, "other textiles"	1 12	A	27 7	

Total net output, 1935, £157·5 *mn*

Index for 1935 (1946=100).

1935 *weights*	138
1946 *weights*	146

Total weight of group	251·6
Of which:	
Production and delivery series	195 3
Input series	26 2
Employment series	30·1

TRADE as defined in 1935 Census of Production (1935 net outputs in brackets).	Minimum List Headings.	Reference No	INDICATORS USED (Production unless otherwise shown)	Approximate Ratio of 1946 to 1935 Output (by volume).	Method of Obtaining Weight.	Weight	NOTES.
2. Clothing and Leather.							
Tailoring, Dressmaking, Millinery, etc. *less* Corsets and the like Millinery *plus* Fur. (£50·5 mn.)	132 140 141 142	2 1	Supplies of woven wool cloth for home civilian clothing (square yards).	0 84 (whole trade).	A	51 1	The earnings ratio was obtained from the sum of the earnings for "Tailoring, Dressmaking and Millinery" and "Shirts, Collars, Underclothing, etc." Half the weight was given to each indicator. The 1935 comparison was based on the value of output shown in the 1946 Partial Census of Production
		2 2	Supplies of woven non-wool cloth for home civilian clothing (square yards)	—	A	51 1	
Boot and Shoe. *less* repairing firms (omitted from Index). (£18·8 mn.)	148	2 3	Production for home civilian use of men's and women's boots and shoes with leather uppers (pairs)	0·79 (see note)	A	23 1	The weight for the sub-group was divided in the ratio 2:1. on the basis of a rough valuation of the 1946 outputs. The 1935 comparison used a more complete classification by seven types ; the consolidated ratio only is shown.
		2 4	Total production for all uses *less* series (2 3)	—	A	11 5	
Hat and Cap *plus* Millinery (from tailoring, etc.) (£6·5 mn.)	143	2 5	Employment, Hats and Caps	0 47	A	6 3	The 1935 comparison was based on the 1946 Partial Census.
Glove. Umbrella and Walking Stick *plus* Corsets and the like (from Tailoring, etc.) (£4 0 mn.)	147	2 6	Employment, "Other Dress Industries"	0 65	A	5 4	
Fellmongery. Leather Tanning and Dressing £8·1 mn.).	130	2 7	Heavy finished leather (Sole *plus* Other) (tons).	1 05 (all hide leather)	A	7 4	The earnings ratio for "leather tanning, currying and dressing" was used.
		2 8	Light finished leather (Upper *plus* Lining *plus* Other) (tons)	—	A	7 4	Half the weight was given to each series. The 1935 comparison was based on the Census of Production and used figures for the total make of hide leather.
Leather goods (£2 6 mn.)	131	2 9	Value of output, *deflated* by average earnings per head per hour in the trade	0 82	A	5 0	1935 comparison based on the Census of Production.

Total net output, 1935, £90 5 *mn*

Index for 1935 (1946=100).
1935 *weights* 123
1946 *weights* 123

Total weight of group . 168·3
of which:
Production series 49·4
Input series ... . 102·2
Value series (deflated) ... 5·0
Employment series 11·7

3. Metal Production.

(all items in tons)

Metalliferous mines and quarries (£2·3 mn.).	11 19(1)	3 1	Iron ore	1 12	A	4 6	
Iron and Steel (Blast furnaces) (£4 1 mn).	40	3 2	Pig iron	1 21	A	11 3	
Iron and Steel (Smelting and Rolling) Tinplate. Wrought Iron and Steel Tubes. Wire. (£51 3 mn).	41 43 44 93	3 3 3 4	Steel ingots and castings Net deliveries of finished steel (other than for conversion by other steel firms)	1 28 *(see note)* —	A A	63 7 63 8	The earnings ratio was obtained from the sums of the earnings for "Steel melting and Iron Puddling, Iron and Steel Rolling, etc.," "Tin Plates," "Iron and Steel Tubes," and "Wire, Wire Netting Wire Ropes, etc." Half the weight was given to each indicator. The 1935 comparison was based on the output of steel ingots and castings, together with half the imports of ingot and semi-finished steel, thus allowing for the value of finishing done in this country on imported steel
Copper and Brass (Smelting, Rolling, etc) (£7 0 mn)	49(1)	3 5 3 6	Unalloyed copper products Brass and other alloy products	1 36 (see note)	E E	10 5 13 2	The weight (see note E) was split according to the 1935 gross outputs The 1935 comparison used (in place of both series) the home consumption of virgin copper.
Aluminium, Lead, Tin, etc. (Smelting, Rolling, etc.), but *excluding* nickel, type metal, and other metals and alloys (apart from aluminium, lead, tin and zinc) (£5·8 mn.). The exclusions noted above are *omitted* from the Index ; so also is Gold and Silver Refining. These omissions represent a net output of £5 0 mn. in 1935.	49 (part)	3 7 3 8 3 9 3 10 3 11	Virgin Aluminium production Fabricated aluminium. Tin metal—total disposals. Refined lead—home consumption. Virgin zinc—home consumption.	2 10 3 45 0 83 0 62 1 06	E E E E E	13 7 13 6 4 0 2 3 1 0	In place of series (3 8), the 1935 comparison used the total disposals of virgin aluminium.

Total net output, 1935, £70 5 *mn.*

Index for 1935 (1946=100)
1935 *weights* 77
1946 *weights* 75

Total weight of group 201 7
Of which:
Production series 198 4
Input series 3 3

TRADE as defined in 1935 Census of Production (1935 net outputs in brackets)	Minimum List Headings	Reference No	INDICATORS USED (Production unless otherwise shown)	Approximate Ratio of 1946 to 1935 Output (by volume)	Method of Obtaining Weight	Weight	NOTES
4. Shipbuilding and Repairing.							
Shipbuilding (Private firms) (excluding naval building) *and* Marine Engineering (from Mechanical Engineering) (£19 2 mn.)	50(2) 51(2)	4 1	Employment in merchant ship repairing and conversion in private yards	2 00	1	35 0	1935 employment estimated from the Census of Production
		4 2	(i) For A series (included in total A index, but unpublished) Vessels, 100 gross tons and over, completed (gross tons)	2 14	1	55 0(A)	
			(ii) For B series Vessels, 100 gross tons and over, keel-laid, launched and completed (Lloyd's Register quarterly figures; index published quarterly, but monthly figures for inclusion in the total index are calculated, using the sum of the Admiralty figures for keels laid and completions to indicate a trend for interpolation or extrapolation)	2 19	F	55 0(B)	For the 1935 comparison, launchings were used
The work of Naval Dockyards is outside the scope of the Index; the ship repair work of dock and harbour undertakings is omitted							

Total net output, 1935, £19 2 *mn*

Index for 1935 (1946=100)
1935 weights *A* 48 *B* 47
1946 weights *A* 48 *B* 47

Total weight of group 90 0
Of which
Production series 55 0
Employment series 35 0

5. Motors, Cycles and Aircraft.

Motor and Cycle (Manufacturing firms) (£55 5 mn.) All repairers are omitted	79 (part) 80 (part) 83 (part)	5 1	Passenger cars, not exceeding 1,600 cc, for home market and export, and passenger cars for Services (no).	0 92 (whole group)	G	28 4	Service vehicles were classified with the small cars and the heavy trucks, because they have alternative civilian uses See note G for details of 1935 comparison 1,600 cc corresponds roughly to 12 h p
		5 2	Passenger cars exceeding 1,600 cc, for home market and export	—	G	9 0	
		5 3	Commercial vehicles under 15 cwt, for home market and export	—	G	7 0	
		5 4	Commercial vehicles for Services and those of 15 cwt and over for home market and export	—	G	26 0	
		5 5	Public Service vehicles, for home market and export	—	G	8 0	
		5 6	Motor cycles (no)	—	G	4 0	
		5 7	Pedal cycles (no).	—	G	8 4	
Aircraft (£8 5 mn including production for Services *say* £6 0 mn without)	82 (part) 83 (part)	5 8	Index of structure weight of aircraft for home civilian and for all export uses	n a	G	10 0	See note G For lack of an appropriate indicator the weight of this sub-group was given to Motors and Cycles in the 1935 comparison

Total net output, 1935, £61 5 *mn* — *Index for* 1935 (1946 = 100): 1935 *weights* 108; 1946 *weights* 108 — *Total weight of group* All *Production series*. 100 8

6. Industrial Machinery and Equipment.

Mechanical Engineering (i) Locomotives, rail, standard gauge, including those produced by Railway Companies (£4 0 mn est)	84 (parts) 85 (parts)	6 1	Main line locomotives (no)	0 98	H	16 2
(ii) Coal mining machinery (£1 0 mn est).	69 (part)	6 2	Coal cutters delivered (no)	(2 0)	H	4 5
		6 3	Coal conveyors delivered (no)	(2 0)	H	4 5
(iii) Excavating machinery (£0 4 mn est)	69 (part)	6 4	Excavators (no)	n a	H	1 0
(iv) Air and gas compressors and exhausters (£0 6 mn est)	69 (part)	6 5	Compressors (no)	n a	H	1 0

TRADE as defined in 1935 Census of Production (1935 net outputs in brackets)	Minimum List Headings	Reference No	INDICATORS USED (Production unless otherwise shown)	Approximate Ratio of 1946 to 1935 Output (by volume)	Method of Obtaining Weight	Weight	NOTES
6. Industrial Machinery and Equipment—*(continued)*							
(v) Remainder of the Trade, *except for* Marine Engineering and for metal windows and door frames, and for gas meters, *plus* Tool and Implement (£87 6 mn.)	52 53 54 55 56 58 (part) 69 (part) 80 (part) 85 (part) 90(1)	6 6	*Sum* of the following values of production or deliveries, *deflated* by the average value index of exports in Group IIIG of the Export Accounts (i) Welding sets, arc and resistance.* (ii) Agricultural tractors, machines and implements † (iii) Hosiery machinery and accessories (iv) Other textile machinery and accessories. (v) Metal working machine tools (vi) Wood working machine tools (vii) Internal combustion engines (viii) Steam engines (ix) Water tube boilers. (x) Shell boilers (xi) Fuel oil burners. (xii) Other steam-raising plant accessories (xiii) Industrial valves * (xiv) Pumps and pumping plant. (xv) Printing and book-binding machinery. (xvi) Tobacco and cigarette-making machinery. (xvii) Typewriters. (xviii) Accounting machinery (xix) Other office machinery. (xx) Domestic refrigerators † (xxi) Commercial refrigerators † (xxii) Industrial refrigerators (xxiii) Water treatment plant * (xxiv) Industrial furnaces * (xxv) Railway points and crossings, brakes, and signalling, telegraph and track equipment.*	1 33 (hand tools) 0 67 (constr engineering) 1 47 (rest)	H	270 0	*Omitted in 1935 comparison. †1935 figures estimated from Census.

Electrical Engineering. (i) Electrical Machinery *less* vacuum cleaners (£16 7 mn est.).	70	6 7	Rotating electrical machines —motors, alternators and D C generators, 1-250 h p. KVA or KW, *plus* fractional horse-power motors and rotary convertors : Value *deflated* by average value index of exports in group IIIG	1 55 (see note I)	I	40 9	
		6 8	Hydraulic turbines (in thousand B.H P) *plus* steam turbo-alternators, 10,000 K W. and over (in thousand K.W)	—	I	23 0	Evidence obtained suggested that the value per B H.P. of a hydraulic turbine was similar to the value per K.W of a steam turbo-alternator : the series were therefore added When up-to-date figures for series 6 8 are absent it is made to move with series 6 7.
(ii) The remainder of this Trade is in Group 7.							
Railway Carriage and Wagon Building (Private Firms) *plus* estimated similar output by railway companies *less* an estimate for repairs (£5 9 mn est.).	86 (part)	6 9	Coaches and rail motor vehicles (no)	0 41	A	4 4	The weight was split between the indicators on the basis of 1946 numbers and the relative values shown by the 1935 Census
		6 10	Wagons (no)	1 34	A	12 3	
Total net output, 1935, £116 2 *mn*			*Index for* 1935 (1946=100)		*Total weight of group*	377 8	
			1935 *weights* 74		*Of which*		
			1946 *weights* 74		*Production series*	66 9	
					Value series (deflated)	310 9	
7. Other Metal - Using Trades.							
Iron and Steel (Foundries) (£22 9 mn).	42	7 1	Deliveries of iron castings (tons)	0 92	A	49 1	To a 1935 weight of 4 9 (representing engineering castings) the earnings ratio for "General Engineering" was applied to the remaining 18 0. the ratio for "Stove, Grate, Pipe, etc , and General Iron Founding" The 1935 comparison was based on a more detailed matching of Census output statistics for 1935 against British Iron and Steel Federation statistics for 1946.
Cutlery (£2 4 mn)	90(2)	7 2	Table cutlery *plus* spoons and forks (no.).	0 74	A	8 9	The earnings ratio for "Hand tools, cutlery, saws and files" was used

TRADE as defined in 1935 Census of Production (1935 net outputs in brackets)	Minimum List Headings	Reference No	INDICATORS USED (Production unless otherwise shown)	Approximate Ratio of 1946 to 1935 Output (by volume).	Method of Obtaining Weight	Weight	NOTES
7 Other Metal Using Trades— *(continued)*							
Hardware, Hollow-ware, Metallic Furniture and Sheet Metal, Chain, Nail, Screw and Miscellaneous Forgings, Needle, Pin and Metal Smallwares (£30 7 mn.).	91 92 94 99 (except 99(2))	7 3	Employment—Metal Industries not separately specified *plus* Bolts, Nuts, Screws, Rivets Nails, etc	1 22	A	97 6	
Small Arms trade *omitted*							
Mechanical Engineering.							
(i) Metal casements, window frames and door frames (£2 0 mn.)	99(2)	7 4	Metal windows and doors, steel and aluminium (sq ft)	1 09	H	8 1	
(ii) Gas meters (£1 8 mn.)	69(5)	7 5	Gas meters (no)	1 37	H	7 3	The 1935 production was obtained from the Census
Electrical Engineering							
(i) Electrical machinery — vacuum cleaners (£1 9 mn. est)	71	7 6	Vacuum cleaners (electric) (no)	1 66	J	8 9	
	72 73 74 75	7 7	Insulated wire and cable (value, *deflated* by export average value for telegraph and telephone cables and wires)	0 95	J	42 8	The 1935 production was estimated from the Census
(ii) Remainder of the trade (£38 7 mn est.).	79(2)						
		7 8	Domestic and car radio receiving sets (no)	0 80	J	31 7	
		7 9	Radio valves (no)	1 15	J	6 5	The 1935 production was obtained from the Census
		7 10	Electric lamp bulbs (including flash lamp bulbs) (value, *deflated* by export average value for "bulbs and discharge lamps, complete, ready for use")	1 82	J	6 5	
		7 11	Deliveries of accumulators (value, *deflated* by export average value for accumulators for motor vehicles)	2 03	J	7 4	The 1935 production was estimated from the Census
		7 12	Dry cells (no. of unit cells)	n.a (see note K)	J	7 4	

		7 13	Electric meters (no)	82	J	6 5	The 1935 production was obtained from the Census.
		7 14	Electric fires (no)	1 95	J	4 2	
		7 15	Electric irons	2 49	J	3 3	
		7 16	Electric cookers	0 54	J	1 9	
		7 17	Electric wash boilers	2 74	J	1 0	
		7 18	Electric water heaters (immersion).	(1 50)	J	1 9	
Carriage, Cart and Wagon (£1 1 mn).	89	7 19	Prams and folders (no)	1 28	A	3 1	The indicator is the principal product of this trade. For the 1935 comparison a separate indicator for push chairs was used
Finished brass (£6 8 mn)	95	7 20	Brass and other alloy products delivered (tons)	0 87	A	17 1	The earnings ratio for "Brass and allied metal wares" was used The indicator (which is the same as 3 6) is here regarded as a measure of input The 1935 comparison was based on employment
Plate and Jewellery (£4 6 mn)	102 (part)	7 21	Total value of production of jewellery and artificial jewellery *deflated* by average earnings per hour of all workers, "Watches, Clocks, Plate, Jewellery etc"	0 72	A	3 0	The earnings ratio for "Watches, Clocks, Plate, Jewellery, etc," was used The weight was split between the two indicators in proportion to 1935 gross outputs. The 1935 output was estimated from the Census of Production
		7 22	Total value of production of goldsmiths' and silversmith wares, *deflated* by average earnings (as 7 21)	0 62	A	3 3	The 1935 output was estimated from the Census of Production
Watch and Clock (£0 7 mn)	101 (part)	7 23	Clocks (mechanical *plus* electrical) *plus* Watches (no)	2 07	K	3 0	
Scientific Instruments. Appliances and Apparatus (£6 8 mn)	100 102 (part)	7 24	Employment, Scientific and Photographic Instruments and Apparatus	1 80	A	25 0	Weight reduced from 35 3 (as shown by method A) to remove finished munitions.
None (£0 0 mn)	58 (part)	7 25	Hulls of temporary houses—aluminium (no)	∞	L	6 8	
		7 26	Hulls of temporary houses—other	∞	L	21 8	

Total net output, 1935, £120 4 *mn*

Index for 1935 (1946 = 100)
1935 *weights* 82
1946 *weights* 86

Total weight of group 384 6
Of which
Production series 181 4
Input series 17 1
Value series (deflated) 63·5
Employment series 122 6

TRADE as defined in 1935 Census of Production (1935 net outputs in brackets).	Minimum List Headings.	Reference No.	INDICATORS USED (Production unless otherwise shown).	Approximate Ratio of 1946 to 1935 Output (by volume).	Method of Obtaining Weight.	Weight.	NOTES.
8. Food, Drink and Tobacco.							
Grain Milling (£12 0 mn.)	150 (part)	8 1	Flour milling—wheat milled (tons)	0 94	A	23 9	
		8 2	Maize—total disposals	0 07	A	0 2	The 1935 comparison was based on actual tonnage of maize milled in 1935, and an estimated figure for 1946. The low weight for maize arises from the fact that the 1946 quantity was only 1/14 of 1935
Bread, Cakes, etc. (£28 3 mn.).	151 154(2)	8·3	Flour disposals for food in the U.K. (tons).	1 22	A	28 8	(8·3) is an input series, (8 4) reflects to some extent the elaboration of the work done. The two series were given equal weight.
		8 4	Employment—Bread, Biscuits, Cakes, etc	0 85	A	28 8	
Biscuit (£9 2 mn.)	152	8·5	Biscuits (tons).	1 02	A	25 5	Carries weight 6 7 from "other preserved foods" (see below).
Cocoa and Sugar Confectionery (£17 6 mn.).	156	8 6	Cocoa *plus* national milk cocoa *plus* drinking chocolate (tons).	1 37	M	2 0	The sub-group carries weight 9 5 from "other preserved foods" (see below, and note M)
		8 7	Chocolate—category I.	0 82 (8 7 to 8 10)	M	4 4	
		8 8	,, —category II.	—	M	8 3	
		8 9	,, —categories III and IV.	—	M	1 3	
		8·10	Other production of chocolate and chocolate confectionery.	—	M	5 1	
		8·11	Sugar confectionery—category I	0 48 (8 11 to 8 14).	M	4 3	
		8 12	Sugar confectionery—category II.	—	M	5 9	
		8 13	Sugar confectionery—category III and IV.	—	M	1·3	
		8 14	Other production of sugar confectionery.	—	M	1 0	
Preserved Foods (i) Marmalade, jams and fruit jellies (£2 9 mn.).	157(1)	8·15	Jam and marmalade (tons).	1 26	A	9 8	Carries weight 2 9 from "other preserved foods" (see below). These three sub-groups used the earnings ratio for "other food industries."

(ii) Breakfast cereals (£1·0 mn. est.).	150 (part)	8 16	Consumption—oatmeal and flakes, and other breakfast cereals (tons).	1 72	A	3 4	Carries weight 1 0 from "other preserved foods" (see below) Production assumed to move with consumption. 1935 comparison based on oatmeal and flakes only.
(iii) Other preserved foods: preserved meat, fish, fruit and vegetables, pickles, sauces, custard powder, etc. (£11 9 mn.).	157(2) 153(3) 162 (part)		None	—	A	—	There being no direct indicator available the weight (28 2) was spread over six other sub-groups (as indicated in the notes) in a ratio based upon the relative importance of the groups.
Bacon Curing and Sausage (£6·4 mn.).	153(2)	8 17	Bacon and ham (tons).	0 56	N	15 9	A weight of 6 3 from "other preserved foods" is carried (see above).
Butter, Cheese, Condensed Milk and Margarine (£6·9 mn.).	154(1) (part) 162(1)	8 18	Butter (tons).	0 52	A	1 3	The earnings ratio for "other food industries" was used for the total of this sub-group, and split in the light of quantity movements since 1935. The 1935 figure for Milk Powder was obtained from the Census of Production.
		8 19	Cheese.	0·44	A	0 5	
		8 20	Condensed Milk	0 53	A	2 4	
		8 21	Milk Powder	1 68	A	1 3	
		8·22	Margarine.	1 89	A	10 8	
Sugar and Glucose (£5 3 mn.).	155	8 23	Total of sugar entered for home consumption (tons).	0 70	A	8 6	All in this sub-group used the "other food industries" earnings ratio. (8 23) carries the weight of refining, (8 24) of beet sugar production, and (8 25) the estimated weight of glucose production. The 1935 glucose production was estimated from the Excise accounts
		8 24	Sugar production from home-grown sugar beet.	0 99	A	3 1	
		8 25	Glucose.	0 69	A	0·9	
Fish Curing, Ice (£1 8 mn.).	162(2) 162(6) (part).	8 26	Fish—landed weight (tons).	See note O.	O	3 5	
Cattle, dog and poultry-foods (£3·6 mn.).	162(3)	8 27	Consumption of oilcake and meal—high and medium protein *plus* low protein (tons).	0 52	P	5 0	
Brewing and Malting, Wholesale Bottling—bottlers of beer, ale, stout and porter (£50 9 mn.).	163 164 (part)	8 28	Beer (bulk barrels).	1 40	Q	100 5	
Spirit distilling (£2·3 mn.).	168(1) (part)	8 29	Spirits Distilled in the U.K. (proof gallons).	1 23	Q	4 1	
Spirit rectifying, compounding and methylating, Wholesale Bottling (rest of trade). *less* methylating (£7·2 mn.).	164 (part). 168(1) (part).	8 30	Spirits—Charged with Duty *plus* Free of Spirit Duty for Exportation, etc (U K.)(proof gallons).	1 08	Q	11 5	The indicator in effect represents the deliveries of potable spirits after maturing, bottling, etc.

TRADE as defined in 1935 Census of Production (1935 net outputs in brackets).	Minimum List Headings	Reference No.	INDICATORS USED (Production unless otherwise shown).	Approximate Ratio of 1946 to 1935 Output (by volume).	Method of Obtaining Weight.	Weight.	NOTES.
8. Food, Drink and Tobacco—(*continued*).							
Aerated waters, Cider, Vinegar and British Wine (£5·9 mn.).	162(4) (part).	8 31	Soft Drinks (gallons)	n.a.	R	10 0	
		8 32	Cider and Perry.	1 37	R	2 0	
	168(2) 168(3)	8 33	Sweets, including British Wines	0 61	R	1 0	
Tobacco (£28·4 mn.).	169	8 34	Total tobacco entered for home consumption (lb.)	1 47	A	56 3	The indicator measures the quantity of tobacco leaf released for manufacture in this country
Total net output, 1935, £201 6 *mn.*			*Index for* 1935 (1946=100)		*Total weight of group*	392 7	
			1935 *weights* 90		*Of which:*		
			1946 *weights* 97		*Production series (or consumption of finished product)*	237 6	
					Input series	126 3	
					Employment series	28 8	
9. Chemicals and Allied Trades.							
Chemicals, Dyestuffs and Drugs (£36·5 mn.).	31(1) 31(4)	9 1	I.C.I. index of production—all alkalis.	1 23	S	27 7	
	32(1)	9 2	I.C.I. index—Chlorine	1 52	S	4 2	
		9 3	I.C.I. index — Hydrochloric Acid.	1 05	S	3 1	
		9 4	Sulphuric Acid (tons).	1 54	S	17 3	
		9 5	Copper Sulphate (tons)	1 65	S	4 8	
		9 6	Coal Tar distilled (tons).	1 23	S	4 8	
		9 7	Synthetic dyestuffs (lb.).	1 03	S	12 0	
		9 8	Drugs, medicines and medicinal preparations (notional series).	1 85	S	27 5	
Fertiliser, Disinfectant, Glue and Allied Trades (£3 0 mn.)	31(2)	9 9	Superphosphate (tons).	2 06	T	2 0	
		9 10	Compound fertilizers.	2 19	T	8 0	
	39(4) (part).	9 11	Nitrogen content of nitrogenous fertilisers (ammonium sulphate, nitro-chalk, concentrated compound fertilisers, and nitrate of soda (synthetic and Chilean)).	1 93	T	8 0	

Soap, Candle and Perfumery.							
(i) Soap boiling, etc. (£8 1 mn. est.).	35(1) (part)	9 12 9 13	Toilet soap (tons). Other soap products.	1 29 0 88	U U	2 0 7 1	
(ii) Candles, etc. (£0 5 mn).	35(1) (part).	9 14	Deliveries of paraffin wax and scale to candle manufacturers (tons)	n a	U	1 0	
(iii) Perfumed Spirits, Perfumery, Cosmetics and Toilet Preparations, etc. (£4 5 mn. est)	32(2)	9 15	Value of production of toilet preparations *deflated* by the mean of the export average values for " tooth paste or powder and liquid preparations for dental purposes and mouth washes " and " toilet paste or powder ; toilet cream; lipstick, rouge and grease-paint "	1 25	U	9 0	
Paint, Colour and Varnish (£10 8 mn.).	34	9 16	Employment " Paint, Varnish, Red Lead, etc."	1 08	A	25 6	
Seed Crushing (£4 4 mn.).	39(2) (part).	9 17	Seed crushing—oilseeds and nuts crushed (tons).	0 78	W	8 8	
(The Oil and Tallow trade is *omitted* for lack of data · the Petroleum trade is classified in Group 11).							
Explosives and Fireworks (£3 3 mn.).	33 (part).	9 18	I C I index—industrial explosives	1 35	W	8 9	This weight assumes 1946 prices double those of 1935.
Starch and Polishes (£4 3 mn)	35(2) (part). 162(5)	9 19 9 20	Starch (tons) Polishes — floor, furniture, leather, metal, stove and other (cwt)	n a 1 74	W W	2 0 6 6	Starch was omitted from the 1935 comparison ; the 1935-1946 ratio for polishes relates to wax polishes only.
Match (£1 5 mn.)	35(2) (part)	9 21	Matches (boxes).	1 13	W	2 0	
(The Ink, Gum and Typewriter Requisites trade is *omitted*)							
Salt Mines, Brine Pits and Salt Works (£0 8 mn).	19(2)	9 22	Salt (excluding brine) (tons)	0 97	W	2 0	The 1935 quantity was obtained from the Census of Production

Total net output, 1935, £77·7 *mn*

Index for 1935 (1946 = 100)

1935 *weights*	75
1946 *weights*	77

Total weight of group . .	194 4
Of which:	
Production series . .	122 5
Input series . .	9 8
Value series (deflated) .	9 0
Employment series . .	25·6
Notional series .	27 5

TRADE as defined in 1935 Census of Production (1935 net outputs in brackets).	Minimum List Headings.	Reference No.	INDICATORS USED (Production unless otherwise shown).	Approximate Ratio of 1946 to 1935 Output (by volume).	Method of Obtaining Weight.	Weight.	NOTES.
10. Building, Building Materials and Furniture.							
Building and Contracting (£130 mn. est.: see note X).	200 (part). 201 (part) 202 (part)	10 1	New permanent houses—construction *begun* by Government and local authorities and by private builders *plus* war destroyed houses—rebuilding *begun*. *plus half* the conversions and adaptations (Great Britain).	(See note X, A 0 56, B 0 67).	X	A- 0 B-35	The weights shown are alternatives for the A-series and the B-series (see Part I, Chapter 3).
		10·2	New permanent houses *completed* and war-destroyed houses rebuilt, *plus half* the conversions and adaptations.	—	X	A-50 B-35	
		10 3	Erection of temporary houses *begun*.		X	A- 0 B-12	
		10 4	Erection of temporary houses *completed*.		X	A-35 B-12	
		10 5	Unoccupied war-damaged houses—repair completed.		X	A-20 B-20	
		10 6	Sites developed by local authorities in Great Britain, for new permanent and for temporary houses		X	A- 0 B-26	
		10 7	Employed operatives in the building and civil engineering industries in Great Britain, aged 16 and over, engaged in work for industry and agriculture.	—	X	A-60 B-60	The indicator includes those employed in open-cast coal production, which is included in the Fuel and Power section; but it is impossible to eliminate these workers.
Brick and Fireclay *less* Sanitary Ware (£17·2 mn.).	20 (part).	10 8	Building bricks (no.).	0 47	A	22 2	The weights were divided in the ratio of 1935 gross outputs.
		10 9	Clay roofing tiles (squares).	0·42	A	3 2	
From Brick and Fireclay *and* China and Earthenware: Sanitary ware (£3·6 mn.).	20 (part).	10 10	W.C. pans (no.).	n.a.	A	3 0	The earnings series for Brick, Tile, Pipe, etc. Making and for Pottery, Earthenware, etc., yield weights of 5 3 and 6·6
	21 (part).	10 11	Stoneware pipes (tons).	0 63	A	3 0	

							respectively. A mean of 6·0 was taken, and divided equally between the two indicators. In the 1935 comparison W.C. pans were omitted, their weight being given to Stoneware Pipes.
From China and Earthenware—Floor tiles and glazed wall and hearth tiles (£1·7 mn.).	21 (part).	10·12	Glazed wall and ceramic floor tiles (sq. yds).	0·86	W	3 4	
Glass—all *except* Glass bottles and jars and domestic and fancy glassware (see Sundry Trades Group) (£5 8 mn.).	22 (part).	10 13	Flat glass (index of production)	1 60	A	14 3	The earnings ratio for Glass Manufacture was used.
Cement (£5 8 mn.)	24 29 (part).	10 14	Cement (tons)	1·11	A	13 8	
Building Materials (£8 5 mn.)	29 (part).	10 15	Employment, Cast Stone and Cast Concrete Products, Patent Fuel, Stone grinding, etc.	1·67	Y	20·0	
Timber (sawmilling, etc) (£13 8 mn).	170 172 179	10 16	Home production of softwood *plus* consumption of imported and home-grown softwood (standards).	0 48	Z	22 6	
		10 17	Home production of hardwood *plus* consumption of imported and home-grown hardwood (cu. ft).	1 39	Z	17 4	
Furniture and Upholstery (£20 2 mn.).	171 (part).	10 18	Production of utility furniture (index adjusted for changes of relative value).	0 62	A	29 6	The weight obtained for the whole trade, using the earnings ratio for "Furniture Making, Upholstering, etc.," was split as 9 : 1. About 1/10 of the net output in 1935 related to soft furnishings, mattresses being the largest item.
(The remainder of the timber trades is classified in Group 13)		10 19	Mattresses (no).	1 20	A	3 3	
Slate Mines and Quarries (£1·5 mn.).	13	10 20	Roofing Slates, Great Britain (squares).	0 39	A	1·7	The earnings figures for "Other Mining and Quarrying " were used.
Non-metalliferous Mines and Quarries (other than Coal, Salt and Slate) (£11·1 mn.).	12 14 19 (part).	10 21	Employment in Clay, Sand, Gravel and Chalk Pits *plus* Stone Quarrying and Mining.	0 85	A	22·2	The combined earnings ratio from both the employment series was used.

Total net output, 1935, £219 2 *mn.*

Index for 1935 (1946 = 100)
1935 *weights* *A* 149 *B* 135
1946 *weights* *A* 156 *B* 142

Total weight of group 344 7 (*B*379 7)
Of which:
Production series .. .. 206 5 (A)
Input series .. 36 0
Employment series 102·2

TRADE as defined in 1935 Census of Production (1935 net outputs in brackets).	Minimum List Headings.	Reference No.	INDICATORS USED (Production unless otherwise shown)	Approximate Ratio of 1946 to 1935 Output (by volume).	Method of Obtaining Weight.	Weight.	NOTES.
11. Fuel and Power.							
Coal Mines, Manufactured Fuel (£121 5 mn.). also Open-cast coal production.	10 202 (part)	11 1	Coal production, Great Britain, total (including opencast) (tons).	0 86	V	291 0	Additional weight has been allowed for opencast production.
Gas Undertakings (£39 7 mn.).	210	11 2	Gas made at gasworks (therms).	1 34	W	75 4	Coke produced by gasworks (quantity ratio 1·22) was also used in the 1935 comparison.
Electricity Undertakings (£49 7 mn.).	211	11 3	Electricity generated by authorised undertakings (KWH)	2 27	V	85 0	1935 comparison includes generation by transport undertakings.
Coke and By-products (£4 2 mn.)	30	11 4	Metallurgical coke (tons)	1 17	A	9 6	
Petroleum (£3·2 mn.).	36	11 5	Production in the U.K. of finished petroleum products from imported crude and process oils (excluding bitumen) *plus* U.K. indigenous production of petroleum products and substitute fuels (tons)	1 30	W	10 0	
Total net output, 1935, £218 3 *mn*			*Index for* 1935 (1946 = 100) 1935 *weights* 79 1946 *weights* .. 96		*Total weight of group All production series.*	. . 471 0	
12. Paper and Printing.							
Paper (£16 8 mn.).	180	12 1	Newsprint production *plus* twice production of Other Paper and Board (tons).	0 87	A	34 3	The double weight given to "Other paper and board" is a method of allowing for its greater value per ton.
Wallpaper (£2 0 mn.).	181	12 2	Employment, Wall Paper making.	0 53	A	3 0	
Printing, Bookbinding, Stereotyping, Engraving and Kindred Trades *and* manufactured Stationery (£46 6 mn.).	183 189	12 3	Consumption of Printing and Writing paper other than newsprint (Input series) (tons).	0 80 (employment see note AA)	AA	66 0	
Printing and Publication of Newspapers and Periodicals (£37 8 mn.).	186	12 4	Consumption of newsprint (tons).	—	A	52 0	The earnings ratio for "Printing, Publishing and Bookbinding" was used. See also note AA.

Cardboard Box (£7·0 mn.).	182	12 5	Employment, Cardboard Boxes, Paper Bags and Stationery.	0 68	A	11·1	See also note AA.
(The Pens, Pencils and Artists' Materials Trade is included in group 13.)							

Total net output, 1935, £110·2 *mn.*

Index for 1935 (1946 = 100)
1935 *weights* 127
1946 *weights* 127

Total weight of group 166 4
Of which
Production series 34 3
Input series 118 0
Employment series 14 1

13. Sundry Trades.

Rubber (£14 3 mn.).	190	13 1	Consumption of rubber for giant covers (tons).	1 26 (all transport)	A	9 9	The total weight of the sub-group (42 9) was split according to a rough assessment of the several 1935 net outputs multiplied by the quantity movement since that date. An exact division is not possible, since the indicators carry the weight of many miscellaneous uses of rubber. In the 1935 comparison a single figure for rubber tyres was used (Board of Trade Journal 13/9/47); the 1935 Belting figure was found by assuming this indicator to move with the Machinery group index, while footwear was divided between all rubber boots and other types.
		13 2	Consumption of rubber for other transport uses	—	A	20 0	
		13 3	Consumption of rubber for belting (tons)	1 35	A	6 0	
		13 4	Adults' rubber boots (pairs).	1 43 (all boots)	A	2 0	
		13 5	Children's rubber boots and other rubber footwear	0 35 (all other rubber footwear).	A	5 0	
Plastic Materials, Buttons and Fancy Articles (£4 0 mn.).	199 (part) 31(3)	13 6	Synthetic resins produced (tons).	1 84	BB	2 0	
		13 7	Acrylic sheet, casein and PVC produced.	2 31	BB	2 0	
		13·8	Synthetic resins consumed.	n a.	BB	6 0	
		13·9	Acrylic sheet, casein and PVC consumed.	n a.	BB	6 0	

TRADE as defined in 1935 Census of Production (1935 net outputs in brackets).	Minimum List Headings.	Reference No.	INDICATORS USED (Production unless otherwise shown)	Approximate Ratio of 1946 to 1935 Output (by volume).	Method of Obtaining Weight.	Weight.	NOTES.
13. Sundry Trades—(*continued*)							
Linoleum and Oilcloth (£4·5 mn.).	191	13 10	Linoleum (including substitute) (square yards).	0 39	A	4 3	The weights were split in the ratio 2·1. Felt base production was about 1 5 times that of linoleum in 1946, but its value was only about 1/3 as great.
		13 11	Felt Base.	0 87	A	2 1	
Musical Instruments (£2·6 mn.).	103	13 12	Employment, Musical Instruments	n a	A	2 0	Owing to the reclassification of certain workers, the 1935 employment figure is not comparable, and the trade is *omitted* from the 1935 comparison. The earnings ratio was based on 1938 employment.
Brush (£1·8 mn.).	192	13 13	Household brushes, tooth brushes and other toilet brushes (no.).	1 30	A	4 8	The 1935 comparison was based on data for all types of brush.
Games and Toys (£1 6 mn.).	193(1)	13 14	Total value of production of toys and indoor games, *deflated* by the earnings per hour in "Toys, Games and Sports Requisites."	1 68	A	4 1	The 1935 value was obtained from the Census.
Sports Requisites (£1 6 mn.).	193(2)	13 15	Golf and tennis balls (no.).	0 42	A	1 7	The total weight of 4·1 was obtained by using the earnings ratio for "Toys, games and sports requisites." The weight was split in the ratio 2:1·2, which is the approximate 1946 ratio of gross outputs of the goods in these classes.
		13 16	Football cases.	0 77	A	0 8	
		13 17	Racquets and cricket bats.	0 46	A	1·6	
Manufactured abrasives *omitted.*							
Incandescent mantles (£0·3 mn.).	199 (part).	13 18	Incandescent mantles : number sold to home market.	0 55	W	0 3	

Cinematograph film printing (£0·5 mn.). *plus* Film Production (not in 1935 Census but net output estimated as £3·4 mn.).	195	13·19 13·20 13·21	Registrations of British films (feet)—under 3,000 feet ; do. 3,000—6,000 feet ; do. over 6,000 feet.	1 37 0·77 0·38	CC CC CC	1 4 1·0 5·6	
China and Earthenware *other than* Tiles and Sanitary Ware (Group 10) (£6·8 mn.).	21 (part).	13·22	Domestic pottery—total number of pieces produced for all markets, *plus* exports.	0·65	A	12 5	The indicator counts exports twice, thus allowing for their greater average value. The 1935 comparison was based on the value of production given in the Census, taking earthenware and china separately, each deflated by its own export average value.
Glass—other than (10·13).							
(i) Glass bottles and jars (£4·0 mn.).	23	13 23	Glass bottles, jars and syphons, by number.	1 57	A	11 0	
(ii) Domestic and fancy glassware (£0·8 mn.).	22 (part).	13 24	Domestic and fancy glassware —value of output, *deflated* by earnings per hour in Glass Manufacture.	1 32	A	2 0	The 1935 value was obtained from the Census.
Coopering. Cane and Wicker Furniture and Basketware. Wooden Crates, Cases, Boxes and Trunks. (£3·2 mn.).	171 (part). 173	13·25	Employment—Wood Boxes and Packing Cases *plus* Other Woodworking.	1 27	A	9·8	
Pens, Pencils and Artists' Materials (£1·5 mn.).	194 (part).	13·26	Employment — Stationery and Typewriting Requisites (not paper).	0·73	A	2·6	

Total net output, 1935, £50·9 *mn.*

Index for 1935 (1946 = 100).
1935 *weights* ... 95
1946 *weights* ... 106

Total weight of group .. .. 126·5
Of which:
Production series ... ... 58·1
Input series ... ... 47·9
Value series (deflated) 6·1
Employment series ... .. 14·4

NOTES.

A. The 1935 net output of the Census trade (as shown in the first column of the table) was multiplied by the ratio of total earnings per week (mid 1946) to total earnings per week in 1935. The earnings ratio was found from Ministry of Labour figures (a note being added where the Ministry of Labour industry differed seriously, in content or title, from the Census trade). It was calculated as (Insured workers—Unemployed) x Earnings per head per week, the average of the unemployment for all months being used in the case of the 1935 figures. (See also pp. 58 and 81.)

B. The weight for the sub-group (found by method A) was split between the different indicators for that group in proportion to the 1946 gross outputs, roughly estimated by multiplying 1946 total physical output by the export average value for the year for the appropriate classes of the export list.

C. After examining the 1935 and 1946 outputs, cotton doubling was given 1/5 of the combined weight for spinning and doubling.

D. The weight obtained by method A for the rayon weaving and silk sub-group, together with 3·0 from finishing, was split between the constituents according to 1935 net outputs, and the weight for silk was then revised downwards in the light of the fact that consumption of silk in 1935 was about 6½ times that in 1946.

E. Method A can only be applied to these two trades combined, giving a weight of 64·2. To check this and to provide separate weights, another method was also used. The 1935 net output corresponding to each indicator was multiplied by the quantity movement and by a " price " factor equal to the ratio of earnings per head in the two years. Copper consumption was used to give the quantity ratio for the whole copper and brass trade. The weights obtained by this method added up to 52·7 after fabricated aluminium had had its weight increased by a half, to allow for the greater complexity of its products in 1946. The truth was assumed to lie half way between the method yielding 64·2 and that yielding 52·7 ; the weights given by the second method were therefore adjusted proportionately to add up to 58·4.

F. The sum of the 1935 net outputs of the Shipbuilding and Marine Engineering trades, with a deduction of £2·3 mn. for naval work, was split between repairing and shipbuilding ; repairing taking the net output for " repairers only," inflated by the ratio of the value of all repairs done to the value of repairs done by the firms which were " repairers only," while shipbuilding took the remaining net output. These 1935 weights were then multiplied by the " quantity " ratios shown in the fifth column of the table, and by a price factor estimated from the ratio of hourly earnings in 1946 and 1935, to give the 1946 weights shown.

G. Method A could not be applied to the motor trade, because the Ministry of Labour figures of employment included unknown numbers of workers on military aircraft and on the reconversion of the industry to varied peace-time production. The 1935 total production was therefore valued, by classes, according to the export average value for that year ; and the 1946 total production was similarly valued. The gross values so obtained were £83·6 mn. in 1935 and £136·9 mn. in 1946. The net output in 1935 was increased in this ratio, and the total divided between the classes in proportion to the 1946 values obtained as above. The quantity comparison with 1935 was obtained by valuing the production for both years in the full available detail at the 1935 Census average values. The weight of 10 allotted to civil and export aircraft manufacture was based on a broad estimate of the value of such aircraft completed in 1946 and is subject to review if any further information becomes available.

H. In the Machinery trades the indicators used were chosen as representative of the many types of machinery. The earnings ratio for " General Engineering " was 4·06, and for a wider group of trades (including also " Hand Tools, Cutlery, Saws and Files " and " Heating and Ventilating Apparatus ") 4·05. The latter ratio was applied directly to the 1935 net output corresponding to Locomotives, despite the absence of any quantity increase, the indicator being taken as representative of a wider group. In Group 7, the same procedure was applied

to " Metal Windows and Doors " and to " Gas Meters." Coal mining machinery had its weight increased from 4 to 9 (equally divided between the indicators) to allow for the relative expansion of this trade. Excavators and Compressors were assigned an arbitrary weight of 1 each. The remainder of the Mechanical Engineering trade, by method A, would have had a weight of 365 ; this was reduced to 270 to allow for the important element in this trade of finished munitions and for the employment of labour, in 1946, on reconversion work not reflected in finished products ; and also for an element of miscellaneous repair work. In the 1935 comparison, excavators and compressors were omitted ; coal cutters and conveyors were given an arbitrary quantity ratio of 1 to 2. For this comparison, hand tools and constructional engineering (which are in any case not directly reflected by the indicators used) were taken out of the large residual section, the quantity of hand tools being assumed to move with the employment in the trade, and that of constructional engineering with the gross output of the building industry at constant prices (see note X). It would be logical to transfer constructional engineering to the Building section of the Index ; but it was thought best to leave it nominally carried as part of the Machinery trades, with which it is related in the Census, since no monthly indicator for it exists. It should be possible to do a better comparison between 1935 and 1946 when the results of the 1946 Partial Census are fully known.

I. Method A, using the earnings series for electrical engineering, yields a weight of 63·9. This was divided between the indicators in proportion to a rough estimate of the 1935 gross outputs of products of the trade, each product being assigned to the indicator considered likely to represent it best. The 1935 comparison was based on employment in electrical engineering, pending the results of the 1946 Partial Census.

J. Method A, using the earnings series for electrical apparatus, yields a weight of 158·8. The transfer, after 1935, of a certain company into this Ministry of Labour industry causes the earnings ratio to be too high. Deductions must also be made for an element of finished munitions, and for certain repair and maintenance work outside the scope of the index. The weight was therefore reduced to 130. This was then divided into sections in the proportions of the 1935 recorded or estimated net outputs of the subdivisions of the Census trade Within the sections " wireless valves and electric lamps " and " primary batteries and accumulators," equal weight was given to each indicator. The weight for lighting, heating and cooking apparatus was divided between the indicators in proportion to the estimated value of the quantities produced in 1946. In the 1935 comparison, production of fires, irons, cookers and wash boilers was estimated from published figures for 1937 or 1938. The weight for dry cells was spread equally over lamps and valves, an adequate 1935 indicator being lacking. For water heaters a quantity ratio of 1·5 was assumed.

K. The weight shown was based on the estimated value of the quantities produced in 1946

L. The prices ex factory were assumed to have been (in 1946) £1,000 for aluminium houses (see " Economist," 19.10.46) and £650 for other types (see Hansard, 1.12.47). The net output was then taken as half the gross output.

M. The total weight for the cocoa, chocolate and sugar confectionery group is 33·6, being 24·1 found by method A and 9·5 as part of the weight for Preserved Foods. This was then spread over the chosen indicators in proportion to their 1946 gross values, obtained from the 1946 production and from assumed 1946 prices. The categories are defined by price ranges, which change from time to time ; the assumed prices were fixed in these ranges after examining representative retail prices. The residual series (8·10) and (8·14) represent production for the Forces, for export, and for further use in other trades ; a medium price was assumed. The 1935 comparison was based on aggregate series for cocoa and drinking chocolate, for chocolate confectionery and for sugar confectionery only.

N. The 1946 weight was obtained by estimating the movements in price and quantity since 1935. The 1935 comparison was based on the sales of pigs for bacon.

O. The month-to-month indicator (8·26) is assumed to reflect very roughly the input of the curing trade and the demand for ice. The 1935 comparison was based on the export of cured or salted herrings (quantity ratio 0·21) and on fish landings (quantity ratio 0·88) ; the first being the major part of the curing trade, and the second representing the ice, fish paste and fish canning trades. The weight of 3·5 includes 1·8 from " other preserved foods," to cover fish paste and canned fish.

P. 1946 consumption was about half pre-war, but with a large price rise. The weight was therefore taken as 5·0. There being no known production series, the nearest available consumption series is used.

Q. Expert advice showed that the net output of the brewing trade varied more closely with the bulk barrelage produced than with the standard barrelage ; the latter being more related to the input of materials. The weight for beer was obtained by applying to the 1935 net output the ratio of the gross value of the product of the industry (free of tax) in 1946 and 1935. A similar method was applied to the spirit trades.

R. These weights were obtained from those for 1935 by applying rough quantity and price factors. Cider production in 1935 was obtained from the Census of Production, while the 1935-46 movement of Soft Drinks was assumed the same as that of the whole food group.

S. The sum of the weights is obtained from the 1946 Partial Census of Production. No known indicator exists for drugs, and they were assumed to have a price rise of about 160 per cent. from 1935 to 1946, and therefore (using the values of output in the Partial Census) a quantity movement of 185 per cent. For the month to month movement a " notional series " has, for the present, been assumed, rising by about 4 per cent. of the 1946 average per annum (but fluctuating for holidays).

The lowest reasonable estimate of the 1946 net output for drugs is £27·5 mn. ; a weight of 27·5 is therefore assumed, and the remaining weight of the trade is spread over the other indicators in the ratios of the estimated 1946 net outputs which they represent. The indicators are, however, taken as representative of an immensely varied field, and there are no certain principles for the division of the weights

T. Method A, using the earnings series for Chemicals, gave a weight of 11·0 ; but 7·0 was added because of the greater relative expansion of this section of the Ministry of Labour industry. The indicators overlap, and no precise assessment of the correct relative weights was therefore possible ; the weights shown were based on a rough calculation of 1935 gross values. The 1935 comparison used a figure for compound fertilisers from the Census of Production ; the figure for nitrogenous fertilisers was obtained by courtesy of the Fertiliser Manufacturers' Association. No indicators for disinfectants and glue were found.

U. The weights in this section were obtained from the movement of quantities and prices since 1935. The weight for soap was split between the two indicators in the estimated proportion of 1946 gross values. In the 1935 comparison, quantities for soap were obtained from the Census of Production ; candle wax was omitted ; and the value of toilet preparations (obtained from the Census for 1935, and from the Board of Trade for 1946) was deflated by an estimated movement of the export average value for toilet paste or powder, etc.

V. The net output of coal mines and electricity undertakings in 1946, on a definition similar to that used by the Census, was computed directly from their respective annual reports.

W. The weights in these sections were obtained from an assessment of the movement of quantities and prices since 1935. In effect this assumes :

$$\text{Net output 1946} = \text{Net output 1935} \times \frac{\text{Gross output 1946}}{\text{Gross output 1935}}$$

X. Cmd. 7099 (April 1947) estimates the 1946 gross output of the Building and Civil Engineering industries as £500 mn. This figure, however, includes repair work (which is not covered by the Index) and work for public utilities (which is also omitted for lack of data). War damage repairs to houses involving rebuilding or major reconstruction are included in the Index. We can thus deduce a table of gross outputs covered by the Index, and (using assumed ratios of net to gross output based largely on the Census) the corresponding net outputs :

	Gross output.	*Net output (weight, "B" basis)*
	£mn.	£mn.
(*a*) Construction of permanent houses, including conversion and adaptation	139	70
(*b*) Erection of temporary houses . .	25	24
(*c*) Housing site preparation .. .	30	26
(*d*) Repair of war-damaged houses (part)	35	20
(*e*) Work for industry, agriculture, etc.	125	60
	£354 mn.	£200 mn

The gross outputs here taken include additions to work in progress, the last column therefore gives the weights required for the "B" series. The indicators cannot reflect these additions directly ; but in the case of (*a*) and (*b*) above, the weight was equally divided between work begun and work completed, which is a fair approximation to what we require

For the "A" series, the above figures for (*d*) and (*e*) were used. (*c*) disappears altogether, since it represents a stage which yields no finished goods The weights for (*a*) and (*b*) have to be increased to take account of site preparation and adjusted so as to correspond with completions instead of work done, this adjustment involved a large reduction in the case of permanent houses, and a minor increase for temporary houses

The 1935 comparison for the whole industry was based directly on Bowen's figures of gross output at constant prices (London and Cambridge Economic Service, May, 1947), which shows a fall in real output from 417 to 281 between 1935 and 1946. This is on a "B" basis, and the corresponding "A" figures were taken as 417 (as above) for 1935, and as 281 x $\frac{100}{106}$ for 1946 ; *i.e.*, the 1946 quantity was decreased in the ratio

$$\frac{\text{net output of completions}}{\text{net output including additions to work in progress}}$$

The 1935 net output corresponding to the field covered by our Index may be roughly calculated by increasing the 1946 "B" figure of £200 mn. in the ratio 417 to 281, to take account of the quantity movement, and then reducing it by the price factor implied in Bowen's series of output at constant and at current prices. This gives £130 mn. ; it includes, of course, the net output contributed by the small firms engaged on work falling within the field of the Index

Y. The earnings ratio for the Ministry of Labour Trade used in the indicator gives a weight of 31·7, being inflated mainly by the employment of men on temporary housing work which is covered elsewhere. The weight was therefore reduced to 20·0.

Z. Method A, using the earnings ratio for "Sawmilling and Machined Woodwork," gives for the whole trade a weight of 40·0. The 1946 softwood indicator (10·16) was converted to cubic feet (the unit of series 10 17) and it was assumed that hardwoods take 50 per cent. more work per cubic foot than softwoods, so that :

Weight for softwoods/Weight for hardwoods = Cubic feet of softwoods/$\frac{3}{2}$ x Cubic feet of hardwoods (see over).

This gave the split of the weights. The indicators were chosen to take into account home-grown timber twice, since on the average it receives more processing. For the 1935 comparison, home-grown softwood production and consumption were taken at 10 thousand standards/month in 1935; home-grown hardwood production and consumption as 1 million cubic feet/month; and consumption of imported woods was taken as the average of retained imports for 1934-36.

AA. The earnings ratio for "Printing, Publishing and Bookbinding" was applied to a net output £38 0 mn. in 1935; that for "Cardboard Boxes, Paper Bags and Stationery" to a net output £8·6 mn. Consumption of paper is assumed to move with production, subject to periodical adjustments for changes in the proportion exported. After careful examination of the available output and input indicators, including the results of the Partial Census of Production for 1946, it was decided to base the 1935 comparison for the printing, stationery and cardboard box trades on employment series. In this trade the logical problems of quality changes are particularly acute, and the indicator chosen avoids the necessity of deciding the "ratio" of a 4-page newspaper to a 20-page one; the most plausible assumptions would give a result broadly similar to that obtained by using employment. The trades were regrouped as follows for the 1935 comparison:

	1935 net output.
1. Printing, stereotyping, engraving and kindred trades	£38·0 mn
Printing and publication of newspapers and periodicals	37·8
	£75·8 mn

1946 weight (method A) 19·2

Indicator Employment Printing, Publishing and Bookbinding.

	1935 net output.
2. Manufactured stationery	£8·6 mn.
Cardboard box	7·0
	£15·6 mn.

1946 weight (method A): 24·8.

Indicator –Employment Cardboard boxes, paper bags and stationery.

BB. Taking 1935 output figures from the Census, it appears that the physical output of this trade had doubled by 1946: assuming a price-factor of 2, this suggests a total weight in 1946 of 16·0. About three-quarters of the 1935 net output appears to be accounted for by mouldings, buttons, combs, etc., and one-quarter by the production of the plastic materials. The same division was adopted for 1946, the making-up of finished goods being represented by input series; and the weights within each section were split equally between the two indicators In 1935 synthetic resins were more important, but the other materials had a larger relative increase to 1946, and are now believed to be about half the total production

CC. A rough estimate of the 1946 net output for each of the three types of film was obtained from the data about registrations and type of quota for which they qualified.

APPENDIX 1.

Reconciliation of the 1935 *net output covered by the Index and the whole net output covered by the Census of Production.*

	£mn.	£mn.	£mn.
1935 net output covered in the "1935 comparison" ...			1,509·6
Add: Candles, etc. .			0·5
Starch . . .			1·0
Musical instruments			2·6
1935 net output covered in the monthly L.C.F.S. Index			1,513·7
Omitted from the Index :			
(i) Finished munitions made by private firms			
Small arms	0 3		
Ships	2 3		
Military aircraft	2·5		
Other (produced by Mechanical Engineering Trade)	2 4		
		7 5	
(ii) Repair work :			
Boot and shoe .	1·2		
Motor and Cycle .	8·9		
Railway wagon .	1·3		
	-	11 4	
(iii) Certain public bodies :			
Local Authorities	30·5		
Water Undertakings	22·0		
Railway companies (part)	30·8		
Tramway and Light Railway Undertakings	4·1		
Canal, Dock and Harbour Undertakings	2·2		
Government Departments	21·8		
	-	111 4	
(iv) Minor omissions for lack of data .			
Nickel and nickel alloys	2·7		
Type metal and printing type	0·2		
Other white metal alloys .	0·7		
"Other" non-ferrous metals	0 4		
Gold and silver refining .	1·0		
Oil and tallow	5·7		
Ink, gum and typewriter requisites	2·5		
Manufactured abrasives	1·4		
	-	14·6	
		--- --	+ 144·9
Net adjustment, Building and Contracting Trade (small firms added : some repairs and civil engineering omitted : some work re-valued. See Note X)... .			--30·0
Film Production (in Index, but not in Census)			—3 4
Error due to rounding			—0·1
1935 net output covered by the Census of Production ..			1,625·1

APPENDIX 2.

The Standard Classification and the Index.

Throughout, the miscellaneous industries at the end of each Order are represented only by one or two major products. Omissions are only noted where the weight of the industry is also omitted from the Index.

Order.	*Minimum List Heading*	*Description*	*Number of indicator*	*Notes and reasons for omissions.*
I	—	Agriculture, Forestry, Fishing	—	*Omitted*—out of the scope of the Index.
II	10	Coal mining	11 1	
	11	Iron ore mining and quarrying	3 1	
	12	Stone quarrying and mining	10 21	
	13	Slate quarrying and mining	10 20	
	14	Clay, sand, gravel and chalk pits	10 21	
	19	Other mining and quarrying	(3 1) 9 22 (10 21)	
III	20	Bricks and fireclay goods	10 8 10 9 10·10 (part) 10 11 (part)	
	21	China and earthenware (including glazed tiles)	10 10 (part) 10 11 (part) 10 12 13 22	
	22	Glass (other than containers)	10 13 13·24	
	23	Glass containers	13·23	
	24	Cement	10·14	
	29	Other non-metalliferous mining manufactures	(10·14) 10 15	Abrasives *omitted* for lack of data
IV	30	Coke ovens and by-product works	11·4	
	31	Chemicals and dyes	9·1 9 2 9 3 9·4 9 5 9 6 9 7 9 9 9·10 9·11 13·6 13·7	
	32	Pharmaceutical preparations, toilet preparations, perfumery	(9·8) 9·15	
	33	Explosives and fireworks	9 18	Munitions *omitted* as out of the scope of the Index.

Indicators which are not directly related to the industry are placed in brackets.

Order.	*Minimum List Heading.*	*Description.*	*Number of indicator.*	*Notes and reasons for omissions.*
IV—*cont.*	34	Paint and varnish	9 16 9 12	Ink *omitted* for lack of data.
	35	Soap, candles, glycerine, polishes, ink and matches	9·13 9·14 9·20 9·21	
	36	Mineral oil refining	11 5	
	39	Other oils, greases, glue, etc	(9·10) 9·17	See general note at head.
V	40	Blast furnaces	3 2	
	41	Iron and steel melting, rolling, etc., not elsewhere specified	3 3 3·4	
	42	Iron foundries	7 1	
	43	Sheets and tinplate	3·3 3 4	
	44	Iron and steel tubes	3 3 3·4	
	49	Non-ferrous metals smelting, rolling, etc.	3 5 3·6 3·7 3 8 3·9 3·10 3·11	Nickel, type metal and other minor items *omitted* for lack of data.
VI	50	Shipbuilding and ship repairing	4·1 4·2	Work on Naval ships *omitted* as out of the scope of the Index.
	51	Marine engineering	4 2	Work for Naval ships *omitted*
	52	Agricultural machinery (except tractors) ...	6·6	
	53	Boilers and boilerhouse plant	6·6	
	54	Machine tools	6·6	
	55	Stationary engines .	6·6	
	56	Textile machinery and accessories . .	6 6	
	57	Ordnance and small arms .	—	Out of the scope of the Index.
	58	Constructional engineering	6·6 7·25 7 26	
	69	Other non-electrical engineering	6·2 6·3 6 4 6 5 6·6 7·5	
	70	Electrical machinery	6·7 6·8	
	71	Electrical wires and cables.	7·7	
	72	Telegraph and telephone apparatus	—	Assumed to move with other electrical trades (7·6 to 7·18).
	73	Wireless apparatus (except valves) and gramophones. .	7·8	
	74	Wireless valves and electric lamps	7·9 7·10	
	75	Batteries and accumulators	7·11 7·12	
	79	Other electrical goods	7·6 7·13 7·14 7·15 (*cont.*)	Electrical equipment for motor vehicles is in effect partly covered by Group 5.

Indicators which are not directly related to the industry are placed in brackets.

Order.	*Minimum List Heading.*	*Description*	*Number of indicator.*	*Notes and reasons for omissions.*
VI—*cont.*	79 (*cont.*)		7 16 7·17 7 18	
VII	80	Manufacture of motor vehicles and cycles	5 1 5 2 5 3 5·4 5 5 5·6 5·7 6·6	
	81	Motor repairers and garages	—	*Omitted* as out of the scope of the Index.
	82	Manufacture and repair of aircraft	5 8	Repair work *omitted* (as above).
	83	Manufacture of parts and accessories for motor vehicles and aircraft	—	Indirectly covered by Group 5 as a whole
	84	Railway locomotive shops .	6 1 6·6	Repair work *omitted* (as above).
	85	Other locomotive manufacture	6 1 6·6	Repair work *omitted* (as above).
	86	Manufacture and repair of railway carriages and wagons and trams	6 9 6 10	Repair work *omitted* (as above)
	89	Carts, perambulators, etc	7 19	
VIII	90	Tools and cutlery	6 6 7 2	
	91	Bolts, nuts, screws, rivets, nails, etc. . .	7 3	
	92	Iron and steel forgings, not elsewhere specified .	7 3	
	93	Wire and wire manufactures	3·3 3·4	
	94	Hollow-ware	7 3	
	95	Brass manufactures ...	7 20	
	99	Metal industries not elsewhere specified	7·3 7 4	
IX	100	Scientific, surgical and photographic instruments, etc.	7 24	
	101	Manufacture and repair of watches and clocks	7 23	Repair work *omitted* as out of scope of Index.
	102	Jewellery, plate and refining of precious metals	7·21 7 22	Gold and silver refining *omitted* for lack of data.
	103	Musical instruments	13 12	
X	110	Cotton spinning, doubling, etc	1 1 1 2 1·3 1 4	
	111	Cotton weaving, etc	1·5	
	112	Woollen and worsted	1 6 1·7	
	113	Rayon, nylon, etc., production	1 9 1·10	
	114	Rayon, nylon, etc., weaving and silk	1·11 1·12	
	115	Linen and soft hemp	1·13	

Indicators which are not directly related to the industry are placed in brackets.

Order.	*Minimum List Heading.*	*Description.*	*Number of indicator.*	*Notes and reasons for omissions*
X—*cont.*	116	Jute	1·14	
	117	Rope, twine and net	1·18	
	118	Hosiery and other knitted goods	1·15 1·16	
	119	Lace	1·17	
	120	Carpets	1 8	
	121	Narrow fabrics	1·19	
	122	Made-up textiles	(1·19)	
	123	Textile finishing, etc.		Weight spread over other items : see notes on Group 1. Part reflected also in 1·17 and 1·19
	129	Other textile industries	1 19	
XI	130	Leather (tanning and dressing) and fellmongery	2·7 2·8	
	131	Leather goods	2 9	
	132	Fur	(2 1) (2 2)	
XII	140	Tailoring		
	141	Dressmaking .	2·1	
	142	Overalls, shirts, underwear, etc. . .	2 2	
	143	Hats, caps and millinery .	2 5	
	147	Dress industries not elsewhere specified	2·6	
	148	Manufacture of boots, shoes, slippers and clogs (excluding rubber)	2 3 2 4	
	149	Repair of boots and shoes		*Omitted* as out of the scope of the Index.
XIII	150	Grain milling	8 1 8 2 8 16	
	151	Bread and flour confectionery	8·3 8 4	
	152	Biscuits .	8 5	
	153	Meat and meat products	8·17	Wholesale slaughtering is *omitted*. See also note on 157.
	154	Milk products	8 18 8·19 8·20 8·21 (8·3) (8·4)	The sterilizing and bottling of milk is *omitted* Indicators 8·3 and 8·4 carry the weight for Ice Cream.
	155	Sugar and glucose	8·23 8·24 8·25	
	156	Cocoa, chocolate and sugar confectionery	8·6 8·7 8·8 8·9 8 10 8 11 8·12 8·13 8·14	

Indicators which are not directly related to the industry are placed in brackets.

Order.	*Minimum List Heading.*	*Description.*	*Number of indicator.*	*Notes and reasons for omissions.*
XIII—*cont.*	157	Preserving of fruit and vegetables	8·15 —	For Jam and Marmalade The rest of the weight for the Preserved Foods Trade, including some covered by headings 153 and 162, is spread over other items as indicated in the notes on Group 8
	162	Food industries not elsewhere specified	8·22 8 26 8 27 9·19	See note on heading 157.
	163	Brewing and malting	8·28	
	164	Wholesale bottling	(8·28) (8·30)	
	168	Other drink industries	8·29 8·30 8·31 8·32 8 33	
	169	Tobacco	8·34	
XIV	170	Timber	10 16 10·17	
	171	Furniture and upholstery	10 18 10 19 (13 25)	
	172	Shop and office fitting	(10 16) (10 17)	
	173	Wooden containers and baskets	13·25	
	179	Miscellaneous wood and cork manufactures	(10·16) (10 17)	
XV	180	Paper and board	12 1	
	181	Wallpaper	12·2	
	182	Cardboard boxes, cartons and fibre-board packing cases	12 5	
	183	Manufactures of paper and board not elsewhere specified	12 3	
	186	Printing and publishing of newspapers and periodicals	12 4	
	189	Other printing and publishing, bookbinding, engraving, etc	12 7	
XVI	190	Rubber	13·1 13 2 13 3 13·4 13 5	
	191	Linoleum, leather cloth, etc	13 10 13 11	
	192	Brushes and brooms	13·13	
	193	Toys, games and sports requisites	13·14 13·15 13 16 13 17	
	194	Miscellaneous stationers' goods	13 26	The Ink, Gum and Typewriter Requisites Trade (see also heading 35) is *omitted* for lack of data.
	195	Production and printing of cinematograph films	13·19 13·20 13·21	

Indicators which are not directly related to the industry are placed in brackets.

Order.	*Minimum List Heading.*	*Description.*	*Number of indicator.*	*Notes and reasons for omissions.*
XVI—*cont.*	199	Miscellaneous manufacturing industries	7·24 13·8 13·9 13·18	
XVII			10·1 10·2	Minor repair work and most civil engineering including work on the roads are *omitted* as outside the scope of the Index or for lack of data.
	200	Building	10·3	
	201	Electric wiring and contracting	10·4 10·5	
	202	Civil engineering contracting	10·6 10·7 11·1	
XVIII	210	Gas	11·2	Construction work done by public utilities for themselves is *omitted* for lack of data.
	211	Electricity	11·3	
	212	Water	—	*Omitted* for lack of data.
XIX		Transport and communication		*Omitted* as outside the scope of the Index.
XX		Distributive trades		
XXI		Insurance, banking and finance		
XXII		Public administration and defence		
XXIII		Professional services		
XXIV		Miscellaneous services		

Indicators which are not directly related to the industry are placed in brackets.

APPENDIX 3.

The types of indicator used.

(i) In the monthly index :

TYPE OF INDICATOR.	Weight.	% of total weight.
Production in physical quantity	1,977·2	60·4
Input	486·8	14·9
Value of output, deflated	394·5	12·1
Employment	384·5	11·8
Notional (see note S)	27·5	0·8
Total weight, "A" series	3,270·5	100·0

(ii) In the 1935 comparison :

TYPE OF INDICATOR.	Weight.	% of total weight.
Production in physical quantity–		
(*a*) involving no significant adjustments	1,493·8	45·7
(*b*) involving significant adjustments	142·6	4·4
Input—		
(*a*) " reliable " series	179·8	5·5
(*b*) " more dubious " series	143·0	4·4
Value of output, deflated	621·8	19·1
Employment	539·9	16·5
Miscellaneous : items mainly made to move with a related series	144·6	4·4
Total weight	3,265·5	100·0
Weight of items omitted from 1935 comparison, but included in the monthly Index	5·0	
	3,270·5	

APPENDIX 4.

Frequency distribution of the weights ("A" series)

	No. of items.	Weight Covered.	% of total weight.
Weight under 5	76	194·6	6
5 - 9·9	42	308·9	9
10 - 19·9	30	389·2	12
20 - 29·9	22	542·4	17
30 - 39·9	5	173·9	5
40 - 49·9	4	173·0	5
50 - 59·9	6	315·5	10
60 - 69·9	4	253·5	8
70 and over	6	919·5	28
	195	3,270·5	100

There are, of course, more indicators than items in the above list, since certain indicators are added together and given a common weight.

PART III.

HISTORICAL STATISTICS OF INDUSTRIAL PRODUCTION IN THE UNITED KINGDOM

The estimates of industrial production with which this monograph is chiefly concerned relate to the year 1935 and to the months since January, 1946. The aim of this part is to survey briefly the course of British industrial production before the second world war and to link the present estimates on to those of earlier investigators. Except where elsewhere stated the term " industrial production " relates broadly to the output of the mining, manufacturing and constructional trades and of the two public utilities, gas and electricity.

The available information can only be described as fragmentary in early times, though calculations have been made extending back to the eighteenth century. The most comprehensive are those of W. Hoffmann [13, 14] and Lord Beveridge [15, 16, 17]. Hoffman's estimates go back to 1700 and show the immense rise of industrial production, especially in the nineteenth century ; Lord Beveridge's figures begin in the year 1785 and are useful for tracing the course of trade fluctuations, being expressed as deviations from trend.

A new era opened up with the taking of the first Census of Production in 1907 [18] since this and subsequent Censuses [19, 20, 21, 22, 23] and the less complete Import Duties Act Inquiries [24, 25] provide a far firmer basis for output comparisons than is available from any other sources. Consequently from this date until 1935, the date of the latest complete census of production, comparatively reliable estimates can be made linking up 1907, 1924, 1930, 1933, 1934 and 1935, and the estimates for these years can be used as a frame of reference against which to measure the achievements of the various annual and quarterly series available.

A comparison of 1907 and 1924 based on the census of production was made by N. A. Tolles and P. H. Douglas [26] and is incorporated in Table 2. For the period 1924-35 we have adopted the calculations of E. Devons [27, 28] in preference to the alternative calculations of E. C. Rhodes and G. L. Schwartz [29]. The principal difference between the two sets of estimates arises over the fact that full details of output by quantity are given in the censuses for only a small part of the output of many industries. In combining these indices to form indices for the various trades, Rhodes and Schwartz include only products for which a direct quantity measure is available and give each industry index a weight equal to the whole net output of that industry, and then follow the same procedure in combining the group indices even though some of the industries in the groups are not represented at all. This procedure

involves the assumption of correlated quantity movements within trades and industries so that the known quantity movements can be taken as representative of those which are not recorded. In practice, to give examples, this method presupposes that the output of the furniture, wooden crates and coopering industries moves with the output of that part of the sawmilling industry for which quantity measures are available and that shipbuilding production varies with those products of mechanical and electrical engineering which can be measured by quantity.

To avoid these drastic assumptions Devons relied on price (or rather average value) correlation rather than on quantity correlation. He assumed that " where more than half the production of any commodity is returned by both quantity and value, the change in the average value of the remainder, returned by value only, is the same as that returned by both quantity and value." Further, and this is a matter of even greater importance, he arranged by various devices to include such things as clothing, printing and publication of newspapers and building, which are covered by value only. The calculations of Devons linking together 1924, 1930, 1933, 1934 and 1935 are also shown in Table 2.

The remaining measures available are on an annual basis. The first work in this field was done by J. W. F. Rowe for the London and Cambridge Economic Service [30, 31] and was followed by the official index numbers prepared by the Board of Trade [32, 33]. For the present purpose the only use that will be made of these calculations is to provide a rough means of interpolating and extrapolating the estimates given by Devons over the period 1920-38, and for this purpose the annual index of the London and Cambridge Economic Service is the most satisfactory. A detailed examination of the composition of these indices, which served to underline their somewhat unsatisfactory nature, was undertaken by R. and W. M. Stone [34]. The same authors brought together [35] the quarterly series for different trade groups compiled by the Board of Trade, which are scattered with many revisions through the pages of the *Board of Trade Journal*, and corrected them for working days and seasonal variation.

The remaining figures in Table 2 relating to 1946 and 1947 are those described in detail in this monograph, and appeared originally in the *Bulletin* of the London and Cambridge Economic Service [36, 37].

An official index of industrial production, compiled by the Central Statistical Office, appeared in March, 1948, shortly after the new London and Cambridge Index. Unfortunately no detailed comparison of the two sets of numbers is possible since very little information has so far been made available on the composition of the official index. In addition to the general index the official calculations give separate figures for each of the Orders II to XVIII of the Standard Industrial Classification [38]. The weight attached to each order is given but not that of any individual series.

It will be seen that the scope of the official index is rather wider than that of the London and Cambridge Economic Service Index, notably in

that it includes munitions, water supply and most repair work, *e.g.*, at garages. It is impossible to say how these items are represented or what weight is attached to them.

The following description is given in [39], and is all that was available at the time of going to press :

' The index is intended to provide a general measure of monthly changes in the volume of industrial production in the United Kingdom. Mining, manufacturing, building and public utilities are included; but agriculture, transport, distribution, other branches of commerce and public and private services are excluded. The index covers production for the home market, for export, and for the Armed Forces.

' The index is based on about 400 individual production series, most of which represent physical quantities produced. In a few cases, such as clothing, and electrical and mechanical engineering, changes in output are derived from figures of the value of production, adjusted for changes in prices. For building and shipbuilding, where the process of production extends over a long period, and the number of finished products does not provide an adequate measure of current output, the index includes changes in the amount of work in progress.

' The level of production in each month is expressed as a percentage of the average monthly production in 1946. To ensure comparability between different months, adjustments have been made, where necessary, for variations in the number of days (excluding Sundays) in each month. But the index reflects any changes in production caused by public and other holidays or by seasonal factors, for which no adjustments have been made. In combining the individual production series to form index numbers for groups of industries, the general method has been to give each industry, or trade, a " weight " proportional to its estimated net output in 1946. These estimates are based on (i) the net output of different industries in 1935, as shown by the Census of Production, (ii) estimates of the net output of small firms which were not covered by the Census of Production, and (iii) estimates of the changes in the total wage-bill in each industry between 1935 and 1946,obtained from the numbers of insured persons employed and average weekly earnings. In the case of products for which no measure of current output is available, the weights appropriate to these products have been apportioned to other items within the same industry, so that each main industry group is given its proper weight. In form, the index is a weighted arithmetic average . . . '

The comparison with pre-war years (first published in September, 1948) covers the same industries as the current monthly index, the figures being described as very approximate and liable to revision. Both 1935 and 1946 weights are used. The comparison between 1935 and 1946 ' is based on about 235 individual production series, with the addition of 15 series showing changes in employment to cover industries for which there are no production figures. The estimates for intermediate years (1936-8) are based partly on production figures, where these are available, and partly on the Board of Trade Index of Production, which was published before the war.' Index numbers are given separately for mining and quarrying, manufacturing industries, building and contracting, and gas, electricity and water. The description concludes with a statement that a full account of the methods used both for the pre-war comparison and for the monthly index will be published later.

Another index which also extends back to a comparison between 1938 and 1946 has been compiled by the research staff of the Economic Commission for Europe [40].

No attempt will be made here to offer a detailed account of the production trends of the past. Hoffman's estimates are necessarily rough, especially for the earlier part of the period when only a very few series were available. For example, at the beginning of the period the only branches of activity covered were coal, cotton spinning and weaving, tin production, sugar and malt. On the basis of 1913=100, his total index, including building, stood at about $1\frac{1}{2}$ in the early eighteenth century and rose to about $2\frac{1}{2}$ in the 1750's. After this the rate of increase

was somewhat more rapid and the index reached 6½ by 1800. Thereafter it rose rapidly to 12½ in 1825, 30 in the early 1850's, nearly 60 by 1875 and about 90 by the end of the century. By 1935 it stood at nearly 130. According to the calculations given below the early months of 1948 were about 20 per cent. above the 1935 level, so that the last two-and-a-half centuries have on this showing seen industrial production increased by a factor of about 100. An increase of this order seems to be in line with the series brought together by Snyder [41].

In considering this large rise several factors must be borne in mind. In the first place there was a large increase in the population over the period, probably by a factor in the neighbourhood of 8. Second, even at the present time industrial production, even in the comparatively wide sense used here, probably accounts for about 35 to 40 per cent. of the total national product. The other branches have not shown anything like the same development, so that it must not be supposed that the increase in industrial production is synonymous with the increase in real income. According to the calculations of Colin Clark [42] real income per head did not increase by as much as a factor of 2 between 1688 and the 1930's. Finally, even within the field of industrial products great changes have taken place over this long period in the relative importance of different industries and of domestic and factory production. Hoffman's series reflect domestic as well as factory production where they are based on input, but clearly they cannot be expected to give a reliable measure of total output.

From 1907 onwards it is possible to make more reliable comparisons, at least for specific years. Table 2 sets out the movement as shown by the calculations referred to above over the period 1907–1947.

Before considering the changes shown in this table we must make three technical points. The first relates to the basis of weighting adopted in making the comparisons. Over the period covered by Devons the basis of weighting is the net output as shown in the final tables of the 1930 Census of Production. That is to say 1924, 1933, 1934 and 1935 are linked to 1930 by an aggregative index based on 1930 weights. The link between 1907 and 1924 is a Fisher ideal index, *i.e.*, the geometric mean of aggregatives based respectively on 1907 and 1924 weights. Similarly, the link between 1935 and 1946 is the geometric mean of aggregatives based respectively on 1935 and 1946. Finally, 1947 is linked to 1946 on the basis of 1946 weights.

In the second place study [28] was only able to make use of the preliminary results of the 1935 Census of Production as they appeared originally in the *Board of Trade Journal*. The effect of the revisions shown in the final reports has been roughly allowed for here by multiplying the estimates given by Devons for 1935 by the ratio of the final to the provisional totals for the value of net output in the different industry groups. The general effect of this adjustment is to increase the 1935 figures, the total index rising from 119 to 123. In most cases the revisions are comparatively small, with the exception of timber and the clay,

TABLE 2

Movement of British Industrial Production over the Period 1907-1947

(1930 = 100)

Census of Production Classification	1907	1924	1930	1933	1934	1935	1946	1947
Mines and Quarries ..	97	107	100	86	93	93	80	82
Iron and Steel	60	100	100	98	118	127	149	155
Engineering, Shipbuilding and Vehicles		90	100	88	106	131	171	197
Non-ferrous Metals ..	69	91	100	96	122	122	147	159
Chemicals	59	94	100	113	122	121	160	160
Textiles	109	123	100	122	127	134	94	99
Clothing		92	100	109	109	123	97	103
Leather	79	108	100	103	103	120	118	132
Food, Drink, Tobacco	91	89	100	106	105	113	120	120
Timber	67	77	100	106	112	127	91	90
Paper, Printing and Publishing	50	86	100	113	129	134	105	112
Clay, Building Materials, Building ...	67	80	100	103	121	139	96	121
Gas and Electricity .	32	74	100	109	121	132	233	241
Miscellaneous	44	75	100	112	113	113	127	142
Total	75	92	100	103	113	123	125	135

For sources see pp. 121-126.

building materials and building group, both of which have been substantially increased.

Thirdly, a series for gas and electricity, not covered in [28], has been added, while the measure of output given in [28] for other public utilities has been removed. These adjustments, though small, improve the scope of the final index in relation to the annual series given in Table 3.

If we turn now to the table itself the most striking feature is probably the large growth in the total. Over the forty-year period the increase amounted to 80 per cent. If we use the estimate for 1927 given in Table 3 to break the period into two, we find that in the first twenty years the rise was 40 per cent., while in the second it was 29 per cent. This comparison is no doubt somewhat unfair to the second period owing to the proximity of 1947 to the war period. In fact the whole of the gain had been achieved by 1937, as can be seen from Table 3. For industrial production as a whole the level of the first half of 1948 is rather above 1937, so that the highest position reached before the war has now been exceeded.

Apart from the exceptional rise of some 650 per cent. in gas and electricity* the principal gains over the forty-year period took place in the

* Mainly caused by electricity—partly for the reason explained on p. 11.

miscellaneous group, the metal and metal using trades and in chemicals. Building, building materials, timber and the paper group, which had risen considerably by 1935, were much affected by the war and in 1947 were still at a relatively low level. An intermediate position is occupied by leather and the food, drink and tobacco group, both of which have surpassed the 1935 level. The trades which have shown little upward movement over the whole period are mines and quarries, and textiles and clothing taken together. The former reached the highest point in the table in 1924 and in 1947 was considerably below the 1907 level. We may be confident that this last point is also true of textiles, even though there is no separate figure for 1907.

Table 3 shows the annual movement of the total of industrial production as measured by the London and Cambridge Economic Service Index over the period 1920–1938. In the figures given below 1930 has been put equal to 100. On this basis the average of the years 1924–30–33–34–35 is almost identical with the corresponding figure derived from the estimates in Table 2. It can be seen that the movement of the two sets of figures is very similar, but the analysis of the group index numbers in [34] shows some serious discrepancies, so that this result must to some extent be regarded as a fortunate accident.

TABLE 3

Movement of British Industrial Production as Shown by the Annual Index of the London and Cambridge Economic Service

(1930 = 100)

1920	...	99	1925	...	94	1930	...	100	1935	...	121
1921	...	67	1926	...	82	1931	...	90	1936	...	132
1922	...	82	1927	...	104	1932	...	91	1937	...	139
1923	...	84	1928	...	101	1933	...	100	1938	...	125
1924	...	94	1929	...	109	1934	...	113	1947	...	135

The basis of these estimates is fully described in the *Bulletin* of the Service and reference may be made to the last description of the pre-war index given in [43]. The figure for 1920 is almost certainly too high, but the fall between 1920 and 1921 is very clear, followed by a gradual recovery between 1922 and 1924. The great depression was mild in comparison with the experience of most other countries and the 1929 level was surpassed in 1934.

The figures for 1935 to 1938 are difficult to interpret because the index did not include any series directly representing munitions production, and for the reasons discussed in Chapters 2 and 4 it is impossible to say how far the figures should be regarded as including the effects of re-armament.

The movement of the index numbers described in detail in this monograph is set out in Table 4. The total index on basis A showed a rise of about 8 per cent. between 1946 and 1947 and averaged 119 in the first half of 1948. This is 25 per cent. above the average for the first half of 1946, and this increase of about 1 per cent. per month over a period of two years is a creditable achievement, even allowing for demobilisation, etc. The last nine months of the index suggest a state of stagnation, but it is reasonable to hope that this will not continue through the autumn. The situation can best be analysed with the aid of the rough index of the rate of output per working day given on page 49, which seems to show a spurt in the autumn of each year and then remain roughly constant until the next August.

The difference between the A and B series, roughly deliveries and work done respectively, is noticeable in the total index, but is undoubtedly under-emphasised since it proved impossible to measure changes in the great majority of products on both bases. The importance of the distinction is clearly seen in the building, building materials and furniture group in which a comparison between the first halves of 1946 and of 1948 shows that completions had increased twice as much as work done. On a completions basis this group of trades showed an increase of 70 per cent. between the first half of 1946 and the first half of 1948. Other groups showing large increases are: industrial machinery and equipment, + 58 per cent.; motors, cycles and aircraft, + 55 per cent.; and sundry trades, + 50 per cent. There is then a substantial gap, until we come to a second set of groups showing increases less than the average: textiles, + 24 per cent.; metal production, + 15 per cent.; chemical and allied trades, + 15 per cent.; other metal using trades, + 17 per cent.; fuel and power, + 11 per cent.; clothing and leather, + 14 per cent. Of these groups, metal production, chemicals, etc., and fuel and power showed little improvement in 1947 over 1946 and have tended to catch up in the last year or so. At the bottom of the list come two groups which have shown little or no trend and, if anything, a tendency to fall below the 1946 level. They are: food, drink and tobacco, — 1 per cent.; and shipbuilding and repairing, — 7 per cent.

These changes have tended in some cases to move the series back towards their 1935 levels. This was true, for example, of the building, etc., group, which has risen sharply since the end of the war. Textiles, on the other hand, have risen only moderately and are still well below the 1935 level. Metal production and the metal using trades generally are by now well above the 1935 level, even if, as in the case of shipbuilding and repairing, there has been little change since 1946. Thus the relative importance of different trade groups is very different now in comparison with the position in the 'thirties. In part this represents a changed pattern of demand for the products of British industry arising, for example, from the need for capital development and the overriding importance of exports. In part, however, it reflects the need for further adjustment and additional recruitment of labour to the undermanned industries.

TABLE 4. London and Cambridge Economic Service Index of Industrial Production (excluding Finished Munitions)

	Total Index											Building, Building Materials and Furniture					
	A	B	Textiles	Clothing and Leather	Metal Production.	Shipbuilding and Repairing B	Motors, Cycles and Aircraft.	Industrial Machinery and Equipment	Other Metal Using	Food, Drink and Tobacco	Chemical and Allied Trades	A	B	Fuel and Power	Paper and Printing	Sundry Trades	
Weight	1000	1011	77	51	62	27	31	116	118	120	59	105	116	144	51	39	Weight
Av 1935 (approx)	99	98	142	(123)	76	47	108	(74)	(84)	94	76	(153)	(138)	87	(127)	100	Av 1935 (approx)
Av 1946	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	Av 1946
Av 1947	108	107	105	107	101	96	119	123	107	100	100	119	109	103	106	115	Av. 1947
1946																	1946
January	89	90	92	90	92		62	86	86	101	97	68	70	102	91	86	January
February	95	95	98	96	98	97	79	94	92	99	99	72	86	103	93	89	February
March	96	97	102	95	103		79	88	93	98	102	81	91	106	95	97	March
April	93	94	95	94	101		88	93	93	100	98	83	89	94	92	90	April
May	102	102	104	105	106	102	93	100	101	103	103	94	99	102	101	103	May
June	97	97	96	97	97		112	100	98	97	97	97	98	94	93	98	June
July	97	97	96	99	95		85	95	100	99	101	105	104	90	100	98	July
August	93	92	95	97	90	102	99	89	95	93	92	103	101	84	91	92	August
September	107	106	105	108	102		119	107	108	98	103	126	121	99	102	112	September
October	112	111	109	113	108		125	114	113	106	104	127	120	105	116	112	October
November	113	113	111	112	109	99	128	118	117	108	106	125	115	109	119	117	November
December	107	105	97	94	99		133	114	107	97	98	121	107	108	109	105	December
1947																	1947
January	107	106	103	115	104		117	109	110	98	96	112	103	110	109	108	January
February	85	85	72	77	83	96	60	100	75	81	80	79	75	109	91	83	February
March	102	102	100	94	93		100	112	107	97	95	98	91	109	101	114	March
April	104	104	102	103	102		133	115	104	98	95	111	105	100	106	105	April
May	108	108	109	108	103	88	142	115	109	103	102	119	111	99	114	113	May
June	115	113	110	120	109		128	131	115	104	105	129	121	98	117	126	June
July	105	104	104	112	94		127	114	105	102	99	125	116	88	98	110	July
August	101	100	104	103	95	92	108	112	97	98	95	117	109	88	104	106	August
September	114	113	113	117	108		133	128	116	105	106	130	119	99	110	127	September
October	121	119	118	122	111		138	145	121	108	112	137	124	108	110	128	October
November	122	121	121	115	112	109	129	152	122	106	114	141	126	115	109	135	November
December	114	111	110	101	103		118	144	108	96	105	131	114	111	99	121	December
1948																	1948
January	117	117	118	112	113		136	142	117	96	113	130	115	117	109	134	January
February	123	120	124	122	117	81	128	158	118	96	118	139	122	117	108	141	February
March	115	112	116	99	114		125	141	103	95	111	135	116	109	101	133	March
April	124	122	126	113	117		132	160	111	98	118	147	128	113	109	159	April
May	117	115	118	98	111	105	134	152	102	101	113	143	123	105	105	125	May
June	123	121	124	111	116		144	164	106	104	114	147	128	109	110	150	June

Current figures are published in the quarterly *Bulletin* of the London and Cambridge Economic Service. Figures for 1935 and 1948 are subject to revision as more information becomes available The 1935 figures shown in brackets are subject to larger error than the rest of the index For an explanation of the "A" and "B" indices, see p. 16 The shipbuilding series (published on a "B" basis only) is quarterly, the figures being set against the middle month of the quarter

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